Mining Engineers' Examination and Report Book

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PART I

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PREFACE.

The following pages have been arranged to assist prospectors, owners, promoters and others in presenting a concise and comprehensive report on mining properties. Part I contains information and tables pertinent to the compiling of such reports, together with detailed suggestions for filling in the skeleton report, which forms Part II. Mining engineers will, it is hoped, find that the latter may be conveniently and profitably used as a field note book from which the final report may be readily dictated without unnecessary waste of time and labor. Part II is sold separately.

The tables and miscellaneous information given, while incomplete, will, it is believed, be of considerable service to the man in the field who may desire to make various calculations and approximations and may not have the necessary works of reference at hand.

I desire to make especial acknowledgments to Messrs. Charles T. Hutchinson, Edmund Juessen, and Francis J. Dennis, for assistance in the preparation of this volume.

CHARLES JANIN.

San Francisco, December, 1912.

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Examination of Mines.

GENERAL SUGGESTIONS.

The accompanying blank forms (Part II of this book) are intended to be merely suggestive. There is no royal road to engineering, and the skeleton report is simply a convenient form of mining note book indicating the essential factors to be determined in an examination of a mining proposition. It is expected that anyone filling out the pages will use his own judgment and good sense. Any value attached to a report will be based upon the care and thought given to the requirements of the examination, as well as to the experience of the engineer making the examination.

The first pages need little explanation. The name and address of the person making the report and of the one on whose behalf the report is made should accompany the report, also the name and situation of the property examined. If part of the report is by a person other than the one writing it, the fact should be stated. Some engineers follow the practice of putting their signature on each page of their report to prevent any misunderstanding or interpolation of other pages after the report has left their hands.

Claims.—The names and areas of the different claims should be given, and on the page provided for the purpose (page 5, Part II) a plan should be drawn, which in absence of more accurate data need be only a rough sketch showing approximately the relation of the different claims to each other. The name of each claim should be noted on the sketch, and information should be given if the claims are surveyed, or if the sketch is merely indicative of the intentions of the locators. The veins may be traced approximately on the different claims. North should be indicated by an arrow and the magnetic variation given if known. Photographs of the property should be furnished when possible, as they aid greatly in conveying a description of the conditions.

Location.—The situation of the property and method of reaching it should be accurately given. If possible the report

should be accompanied with a copy of the map of the district showing the approximate position of the claims in the district. The character of the wagon roads or trails over which the property is reached should be described, and, if they are in poor condition, an estimate should be given of the cost of putting them in good order. The names and sizes of nearest towns should also be mentioned.

Titles.—State whether the claims are patented, or held by possession only, also if present owners are the original locators. Care should be taken to ascertain if the claims have been properly located in order to secure extra-lateral rights, and not to conflict with other claims of prior location. If the report does not include an abstract of title to the property, it is well to state from whom the information as to titles is obtained, and to have the owners approve of and guarantee the statement made. For further information see 'Examination of Title,' page 25.

Historical.—The past history of the property and the district should be briefly given, also the names and history of any important mines in the vicinity. Pay particular attention to the quantity, character and value of ore treated, the method and cost of treatment, the size of plant, and to profits and dividends if any. This, and other information of value, can generally be obtained from local sources, and from Government and Geological Survey publications.

Topography.—The names of rivers and creeks draining the district should be given and a general outline of the topographical features, such as the character and elevation of hills and mountains, of the surface of claims and the amount of timber and vegetation. When the examination warrants, a contour map of the property should be furnished.

Geology.—The geology should be simply and briefly treated, avoiding theories and not going into discussions as to the probable genesis of the ore, which is too often attempted by the uninitiated. Instead, give a simple description of the country rock on the hanging wall and foot-wall of the vein, and in the immediate vicinity of the mine. State if walls are smooth and accompanied by a gouge, or are 'frozen.' Any pronounced faults should be noted either on the property or in the neighboring mines, also the presence of dikes. See

page 40 for other suggestions in this line. A careful study should be made of the general characteristics of the vein and any peculiarities noted. The form, length, and character of ore-shoots; variations in mineralogical character in depth; information in respect to intersecting veins; changes in wall rock; the presence of dikes or faulting; whether the vein is wet or dry; depth of oxidization; the general experience of the mines in the district as to continuity of ore-shoots; whether any changes have occurred in the character and value of the ore in depth; all these are significant and should be noted. When access can be had to developed mines in the district, information of considerable importance can often be secured.

Mining facilities.—State the transportation facilities and cost of freight from centres for mining supplies, or if supplies can be obtained locally, the cost of the most important. Note the facilities for building sites, dumps, removal of tailing, etc., and whether the climatic conditions interfere with working season. The cost of different classes of labor, also whether labor is abundant or otherwise and class of same should be given. State contract prices for the different kinds of mining development. In this connection it is advisable to get figures from parties who would be willing to take contracts.

State amount of water available for steam and domestic purposes, and also if any is available for power, even if at some distance from the mine. If water for power is available state quantity of minimum flow in cubic feet per minute, the fall obtainable, length of ditch necessary, and approximate cost of ditch construction and power equipment. (See tables and other information pages 63-68.)

State fuel used and its cost, the cost of mining timber and lumber, also whether supply is local and limited. If sufficient data are obtainable give comparison of costs of different fuels at the property. State power used and its cost, also make any possible suggestions for other arrangements whereby a saving in power or fuel costs can be effected.

Equipment.—A description of the entire surface plant should be given, including mills, buildings, power plant, hoisting plant, surface transportation, machine, blacksmith, and carpenter shop, storehouses, board and dwelling houses, offices, etc., and their condition. The description of the mine equipment should include the size and condition of shaft, the system

of hoisting and of underground transportation, and all the facilities for mining, such as distribution of compressed air for power drills, the number of pumps, etc. On the sheet for this purpose (page 20, Part II) a sketch should be made showing the approximate position of the different buildings and their relation to each other, or photographs of the surface equipment can be pasted theren.

Development.—The development work on each claim should be fully described and a sketch furnished showing shafts, tunnels, drifts, winzes, raises, open cuts, etc., by which the veins are developed. This work should be carefully done, and, if a complete survey has been made of the property, a copy of the map should accompany the report. For preliminary reports, and where an accurate survey map is not available or justified, a rough sketch can be made showing the approximate position and extent of the work done (page 24, Part II).

Methods of Working.—The method employed in mining should be stated, including such details as width and character of stopes, method of breaking ore, of supporting excavation, amount of timber required, transportation in stopes and levels, and any suggestions for improvement of methods.

Production.—In addition to returns from any ore treated locally, if any shipments of ore or concentrate have been made from the property, describe them fully and give copy of smelter returns, with actual or estimated cost of mining and transportation.

Method of Ore Treatment.—If there is a reduction plant on the property, a flow sheet and the results of ore treatment can be given. If not, and the conditions of the examination and the development of the property are sufficient to warrant, some preliminary laboratory tests should be made to determine the best method of treating the ore. If a neighboring property having ore of similar character has a plant in operation, or has had ore tests made, the results of these, if obtainable, will aid materially in making preliminary estimates. When the method and capacity of plant has been decided, estimates of the cost of its erection can be secured from different manufacturers, and this information may be made part of the report. If the development of the mine is not

sufficiently advanced for such complete estimates, the probable method should be indicated from the preliminary tests. Suggestions for any improvement in treatment may be briefly outlined. The choice of a method of ore treatment is important; especially is this the case when ores are more or less complex. When an ore can be treated by simple methods or in the case of an operating property where the existing plant is making a high percentage of extraction, the problem is soon solved, but, in other cases, exhaustive tests should be made before deciding the kind and size of plant to treat the ore. It is not good practice to simply adopt a method of ore treatment on the basis that it is successfully treating a somewhat similar ore in another district, for it may prove later on that though there is an apparent similarity, the two ores may have different characteristics and require different methods of treatment. Many failures in metallurgical plants have been made because ordinary methods or precautions were not followed in order to find out the proper value of the property and a suitable method of ore treatment, or whether indeed the ore could be economically treated. The capacity of plant to be erected may be of considerable importance. In one case the ideas of the promoters may be excessive, while in another a plant of small capacity might lose money where one of large capacity would show considerable profit. This is emphasized in cases of low-grade mines and those with high-fixed charges which can only be proportionately reduced per ton by having larger plants.

At times, when considering operating properties, it may be found that a few additions and improvements to existing plant may greatly increase the output or extraction, or both, and that it is better to modify the old than to erect a new plant. The question is a large one and its solution taxes the ability and experience of the engineer.

Sampling.—Samples should be representative of the vein at the point where the sample is taken and of the ore as it will be sent to the mill. Samples should be taken as near as practicable at regular intervals if the vein is wide, or in places where the ore occurs in distinct bands, the samples should be taken in sections and separately assayed; careful descriptions being noted of the different sections. In massive deposits

samples are taken in all directions. The distance between samples and the number of samples to be taken must be determined by the size of the property and the character of the deposit, as well as by the time available and the expense permissible. A few samples well taken are more valuable than any number of 'grab' samples. Care is necessary in securing representative samples. At times, in order to study different features of an orebody, it is advisable to take specimen samples. It should be unnecessary to say, however, that such are not representative of the value of the ore and should not be used other than for a study of ore characteristics. It is also advisable to secure some samples of the country rock in the vicinity of the vein.

If assistance has been obtained in sampling, or if the samples are secured by other than the writer of the report, such facts should be noted. The name of the assayer and copies of assay certificates should accompany the report. Sketches should be made (pages 38 and 39, Part II) in lieu of survey maps showing a plan of the workings, and giving the position, width, and assay value of samples. Good examples of such sketches are shown by Fig. 1, page 13. This is of the utmost importance in averaging assays, and in making estimates of the ore reserves.

After samples have been carefully taken and assayed, the whole result of sampling may be vitiated by improper methods of averaging. The first step in averaging samples is to reduce any erratic high assays to the value of adjacent samples. While a high assay may indicate a rich bunch of ore, experience has demonstrated that no dependence can be placed upon it. After the reduction of high assays a study of the assay plan will indicate the boundaries of ore that can be mined at a profit and all samples outside of these boundaries can be excluded from the averages. Generally speaking only the assays from blocks of ore that will be mined need be included in the averages. Where the width sampled is narrower than the necessary width for stoping and where it is not practical to break the waste separately, the sample value must be proportionately diluted with the blank value of the extra width. Samples are not averaged arithmetically, but by reducing them to foot-dollars. For example:

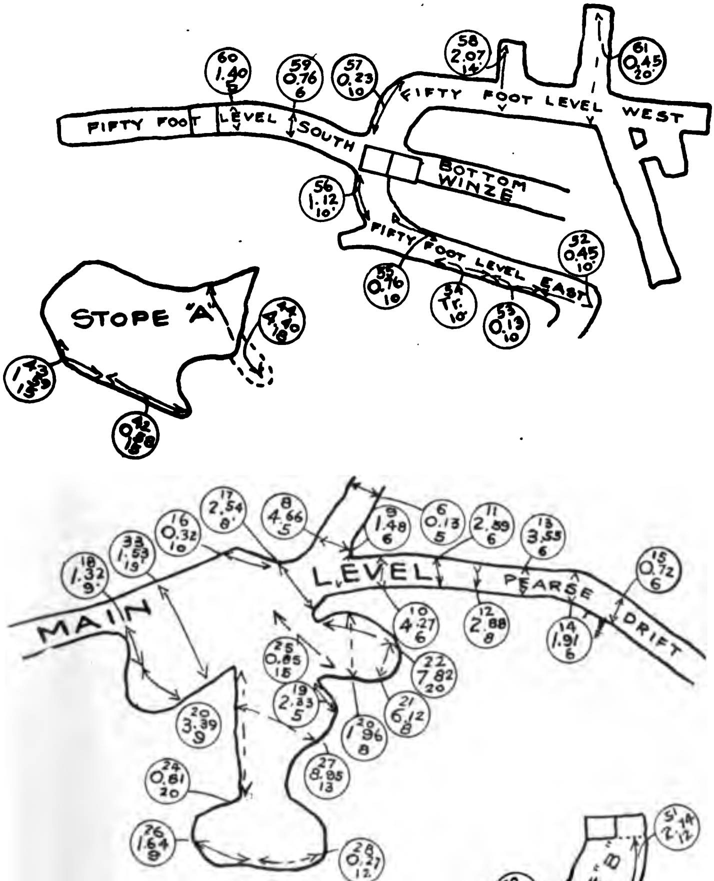

Fig. 1.—Specimen Assay Maps. Arrows point to place where sample was cut; the upper figure is the number of the sample; the middle figure gives the value; and the lower one the width in inches.

Sample.	Width.	Value.	Foot-Dollars.
	ft.		
1	5.0	$ 9.00	$45.00
2	4.0	6.50	26.00
3	4.2	8.75	36.75
4	3.5	7.80	27.30
5	4.5	8.20	36.90
6	5.0	9.60	48.00
7	4.0	50.00 (reduce to $9)	36.00
8	4.0	8.90	35.60
Total.........	34.2		$291.55
Average......	4.25		$8.55

First reduce the high assay to the value of the adjacent samples, in this case to $9. Then multiply the assay of each sample by the width of that sample in feet. The product of the sum of the foot-dollars divided by the sum of the different sample widths will be the average value of the samples, which is, in this case, $8.55. The arithmetical average not reducing the high sample would have been $13.47. A further description of sampling or of the refinement of sample averages is unnecessary here. Those interested can find profitable reading in 'Sampling and Estimation of Ore in a Mine,' by T. A. Rickard and others.

Ore Reserves.—The definition of ore in sight has been taken by engineers in general to mean ore that is developed on three or more sides, though, if the vein is regular and the values persistent, an ore shoot that is opened by several levels may admit of close calculations as to tonnage and value without being so fully developed. To ascertain the number of tons in a measured orebody, multiply the average length, breadth and thickness in feet by each other, and divide the product by the factor representing the average number of cubic feet in that class of material to a ton. The usual measurement of quartzose orebodies is 13 cu. ft. per ton, but this varies with the percentage of sulphides present, and their kind. Ore containing much sulphide requires considerably less than 13 cu. ft. per ton. Homestake, South Dakota, unoxidized ore, containing about 10% finely disseminated pyrite and pyrrhotite, requires but 10 cu. ft. per ton. At Chino, the ore is figured as 13 cu. ft. in place and 21 broken per ton. In dumps, from 20 to 25 cu. ft. of oxidized ore and 16 to 18 of sulphide give the approximate tonnage.

A longitudinal section of the vein should be given on the sheet (page 42, Part II) for that purpose, showing the levels, winzes, stopes and raises that are open. The stoped out section should be shaded and the parts representing ore reserves plainly marked with figures of tonnage and average value. In Fig. 2 the excellent method of plotting ore reserves adopted by the Liberty Bell Gold Mining Company is illustrated by means of a plan in the plane of the vein. In estimating reserves, the ore below the lowest level or beyond developed faces is generally classed as 'probable' and 'possible' ore to a distance assumed in each case beyond openings. Tonnage thus estimated should be clearly defined both on the longitudinal section and in the text. A good method is to state the number of feet beyond developed faces that it is necessary to assume continuity of ore shoot in order to obtain any given estimate of probable or possible ore and, in addition, to indicate on the sketch by a different color each of those portions of the ore reserves so estimated.

Operating Costs.—The operating costs at a mine are governed, among other things, by the size and character of the vein, the hardness of the country rock, depth of mining, amount of water to be handled, cost and efficiency of labor, the metallurgical treatment, magnitude of operation, and the cost of power. A knowledge of these conditions is important in making estimates of operating costs. It is also necessary to consider the situation of the mine, the transportation facilities, the cost and difficulty of obtaining labor, and the cost of supplies. Reliable information as to working costs of neighboring mines operating under somewhat similar conditions will prove a valuable guide in estimating working costs at the property under examination.

Mine Valuation.—In mine valuation it is the ultimate net profit that is the essential feature. The value of any such estimate depends to a great extent upon the experience and judgment of the engineer. The problem obviously is to determine the probability of future production, less the cost of such production. Production costs include, in addition to bare operating expenses, capital expenditure for the purchase of the property, and for equipment and necessary development, all of which should be redeemed during the life of the mine. Every ton of ore extracted should be charged its proper pro-

portion for the return of the investment as well as interest upon such investment.

In cases where the future of a property is mostly prospective, depending upon extension of orebodies in depth, or the finding of new orebodies, the proper valuation of a property is a knotty problem. For valuing ore blocked out, details of assays, of metallurgical treatment, and of operating costs are available or can be estimated from obtainable data; but the probable future of the mine is a matter of judgment based upon geological evidence gathered from a study of the property and of the district in general. It necessitates conclusions as to the persistence of the orebodies in size, value, and in character of mineralogical contents. The engineer's report should differentiate clearly between the value given the property for the ore blocked out and that assumed for ore yet undeveloped, so that his client may recognize some of the inherent risks of the project. After the proper estimation of the probable net profit to be won from a mine is made, it is then required to find the present value of such profits. This depends upon the estimated life given the property and the rate of interest required on the investment. The table on page 17 is most useful for this calculation. At times it may be advisable for the engineer to estimate the value of a property at several different interest rates for the consideration of his clients. The amount of interest which a mining investment should return depends on the risk of the venture and the ideas of the investor. Certainly a minimum of 8% per annum in addition to provision for the return of capital should be demanded, even when there is every reasonable assurance for the return of the latter. A speculation involving a big risk should be compensated for by the possibility of a large gain.

The table (page 17) is taken from 'Principles of Mining,' by H. C. Hoover, and will be found very useful in determining the number of years that a given rate of income must continue in order to amortize the capital and pay a stated rate of interest on the investment. Given the annual percentage of income obtainable or desired, by reference to the table the number of years can be determined over which this percentage must continue in order to amortize the capital and return the desired rate of interest, it being figured that the sinking fund is reinvested at 4% compound interest.

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Example.—Assume that the cost of a mine and equipment is $2,000,000 and that the yearly dividends are $300,000 or 15% of this price. If it is desired to secure a return of 8% on the investment, besides amortizing the capital, it will be seen by reference to the table that a life of 11.5 years will be necessary. If the life of the property has been figured from 'ore in sight' to be six years, then extensions in depth and laterally or new orebodies assuming the same net yearly profit for 5.6 years must be assumed.

Annual Rate of Dividend	Number of years of life required to yield — % interest, and in addition to furnish annual installments which, if reinvested at 4%, will return the original investment at the end of the period.					
%	5%	6%	7%	8%	9%	10%
6	41.0	....	....	....	....	....
7	28.0	41.0	....	....	....	....
8	21.6	28.0	41.0	....	....	....
9	17.7	21.6	28.0	41.0	....	....
10	15.0	17.7	21.6	28.0	41.0	....
11	13.0	15.0	17.7	21.6	28.0	41.0
12	11.5	13.0	15.0	17.7	21.6	28.0
13	10.3	11.5	13.0	15.0	17.7	21.6
14	9.4	10.3	11.5	13.0	15.0	17.7
15	8.6	9.4	10.3	11.5	13.0	15.0
16	7.9	8.6	9.4	10.3	11.5	13.0
17	7.3	7.9	8.6	9.4	10.3	11.5
18	6.8	7.3	7.9	8.6	9.4	10.3
19	6.4	6.8	7.3	7.9	8.6	9.4
20	6.0	6.4	6.8	7.3	7.9	8.6
21	5.7	6.0	6.4	6.8	7.3	7.9
22	5.4	5.7	6.0	6.4	6.8	7.3
23	5.1	5.4	5.7	6.0	6.4	6.8
24	4.9	5.1	5.4	5.7	6.0	6.4
25	4.7	4.9	5.1	5.4	5.7	6.0
26	4.5	4.7	4.9	5.1	5.4	5.7
27	4.3	4.5	4.7	4.9	5.1	5.4
28	4.1	4.3	4.5	4.7	4.9	5.1
29	3.9	4.1	4.3	4.5	4.7	4.9
30	3.8	3.9	4.1	4.3	4.5	4.7

Examination of Placers.

OUTLINE OF PLACER REPORT.

1. Location.
2. Titles.
3. Topography and Geology.—Gravel, note the texture, and presence or absence of cobbles; sands, black sands, amount and distribution of gold, character and content of bedrock; depth of ground, surface contour and timber growth and general conclusions.
4. History.
5. Detailed description of claims—maps; areas of gravel in detail; make contour maps; show dumping facilities; note interference to right of way.
6. Results of sampling; grouping of samples, maps, value of gravel.
7. Conditions governing water supply; water sources, reservoirs; ditches, general description, length, size, grades; pipe lines, flumes; seepage; evaporation; right of way; cost of maintenance.
8. Cost of working and duty of water.
9. Climate, temperature, population, labor and transportation facilities.
10. Erection, operation.
11. Cost of land, royalties, profits to mine.
12. Conclusions.

For a dredging project, in addition to above, costs of fuel, power obtainable, possibilities for hydro-electric power, are necessary. In foreign countries other conditions to be considered would be government, taxes and duties, etc.

The thorough sampling of a placer property is by no means a simple matter, and much depends upon the care taken and the experience of the engineer in charge of the work whether the average value determined for the property will be representative or not of the total gold content. If the greatest care has been exercised in taking a sample, the work being properly done in every detail, the sample will then represent as nearly

as possible the value per cubic yard of the place sampled. While each hole may then be taken as indicative of the value of that portion of the ground where it is sunk, the placing of holes is an important feature.

In deciding upon a method of prospecting, shafts should always be sunk, if possible, in preference to drill holes, as less dependence can be placed on the results from drill tests in regard to the physical conditions and the probable gold content of the gravel than those from shafts. Shaft sinking enables a much larger sample to be taken, gives a better opportunity of examining the character of the gravel, and if the material taken out is carefully handled, there is less chance for error in the work than in drilling. Shaft sinking, however, is limited to favorable conditions while drill tests can be made in any class of ground, and it must be remembered that the value of nearly all the dredging ground in California has been computed from sampling by means of drills.

The chances for making errors in prospecting are great, and the operation is one that requires constant care. In drilling, a careless runner may neglect to drive the pipe ahead of the drill, and may pump out an excessive quantity of material. This may sometimes account for the indication of high values that are not confirmed in subsequent working of the ground. In soft ground, the pipe may be driven too great a distance before pumping and the proper amount of material not secured, as the drill pipe may become clogged and the core fail to increase in proportion to the depth the pipe is driven. The element of risk from salting in securing samples from either shafts or drills depends upon the conditions of examination, care taken, and the experience of the engineer.

The position and distances apart at which samples should be taken can be determined only after a study of the ground is made. Preliminary holes are generally sunk and carefully sampled to determine if the gold occurs in wide or in narrow channels, and if it is fairly evenly distributed throughout the deposit, or occurs in irregular pay streaks. There is no rule as to the number of holes to be sunk, but on ground that shows spotted or irregular contents, obviously more tests will be necessary than where fairly uniform results are obtained. Much time can be saved, in this respect, if the work be carefully planned and directed.

Frequently gulches, old prospect shafts, pits, or hydraulic faces, are available and give considerable information in a reconnaissance of the ground, perhaps sufficient to warrant an engineer of experience in advising his clients to go to no further expense in the examination of the property. He would not, however, be justified in reporting favorably upon the property without making a complete examination.

Sometimes it is feasible to segregate certain sections of a property, eliminating low-grade areas, and on larger areas, where time for the examination is limited, tests to confirm the value indicated by preliminary prospecting may be concentrated on a piece of sufficient size to determine the advisability of purchasing the property and erecting at least one dredge. The accuracy of the figure determined as the average value of placer ground by the examination depends, therefore, upon the care taken in sampling, the number of samples taken, and the situation of the holes in relation to the character of the deposit. All results hinge upon the experience and judgment of the man in charge.

In estimating the value of dredging ground after determining the average value indicated by prospecting, most engineers take a percentage of this indicated value, generally 75 or 80%, as the amount of gold content recoverable by the dredge. These figures are based upon actual tests made to determine the dredge recovery and also upon the percentages of the prospecting value recovered from certain dredged areas.

METHOD OF CALCULATING VALUES OF SAMPLES FROM DRILL HOLES.

The area of a circle the size of the cutting shoe for the Keystone drill generally used is about 0.3 of a square foot, so for every lineal foot drilled in depth there would be excavated 0.3 of a cubic foot or 0.011 cu. yds.; which, as the cutting shoe soon becomes battered, is taken as 0.01 cu. yd. or 1 cu. yd. for each 100 ft. drilled. Using this factor, the method of determining values is as follows:

The gold recovered from a drill hole is reduced to value in cents; if in a new district the fineness of gold must be first determined. The value in cents is divided by number of feet drilled and the result multiplied by 100, which gives value per cubic yard. A less simple method of arriving at the same

results is by using the factor 0.27. Multiply the depth drilled by 0.27 and divide the recovery of gold in cents by the result, to get value per cubic foot; multiply this by 27 to get value per cubic yard.

The following formula can be used when the drilling shoe is of a different size from the above:

$$\frac{\text{Value in cents multiplied by 27}}{\text{Area of shoe in sq. ft. x depth of drill hole in feet}} = \text{theoretical value per cu. yd.}$$

These values are found in practice to be about 25% above actual recovery.

VALUE OF GOLD OF DIFFERENT FINENESS.

Fineness.	Value per oz.	Value per grain.	Value per Mg.
950	$19.36	$0.0409	$0.00063
925	19.12	0.039	0.00060
900	18.60	0.038	0.00060
875	18.08	0.0376	0.00058
850	17.57	0.0366	0.00056
825	17.05	0.0355	0.00054
800	16.53	0.0344	0.00053
775	16.02	0.0333	0.00051
750	15.50	0.0322	0.00049
725	14.98	0.0312	0.00048
700	14.47	0.0301	0.00046
675	13.95	0.029	0.00044
650	13.43	0.028	0.00043
625	12.91	0.0269	0.00041
600	12.40	0.0258	0.00039

COST OF DRILLING.

Keystone Prospecting Drill.*

In California the No. 3 Keystone traction drill is generally used. This is a self-contained machine equipped with an 8 or 10 hp. boiler. For fuel, wood, coal, or oil can be used or, when electric power is convenient, the boiler can be discarded for an electric motor.

*'Gold Dredging in California,' by W. B. Winston and Charles Janin.

The cost of drilling varies greatly with conditions. The drill crew consists of one drillman, or drill runner; one fireman, or helper; one waterman and team; and one panner. When working more than one shift, one waterman is usually able to supply the drill with fuel and water and help in moving the drill and tools from one hole to another. The panner generally works during the day time only, his place being taken by a watchman, who keeps the time log, during the night shift. However, this depends to a certain extent on the depth of the hole and the frequency of moving. The wages of the drill crew are usually as follows, per day:

Drillman	$3.00 to $3.50
Helper	2.50 to 3.00
White panner	3.50 to 5.00
Chinese panner	1.50 to 2.00
Waterman and team	4.00 to 5.00

Aside from the wages of the drill crew, other costs, such as fuel, repairs, maintenance, and hire or purchase of drill, also enter into the total costs. In the winter months heavy rains increase the cost of transportation, making moving difficult, and greatly delay work. A serious accident to the drill machinery might also delay the examination for several days and increase the cost considerably. It is generally figured that the cost of drilling runs from $1.50 to $2.50 per foot under favorable conditions.

In drilling on one property, the average depth per day, including delays caused by bad weather, moving, and the like, over a total period of thirty-three 10-hour days, was approximately 12.6 ft. per day; the holes averaged 24.9 ft. deep, the character of the deposit was medium coarse gravel, free from clay and overlain by hydraulic tailing. The wages of the drill crew were $12.25 per day, so the labor cost in the above examination would apparently be $1.01 per foot drilled. On another examination three 70-ft. holes required eight 24-hour days, including pulling pipe, moving, etc., and the cost for labor was $1.71 per foot.

On an examination in rather loose deposit of sand and gravel, the boulders of granite being easily broken bv the drill, 24 holes of an average depth of 23¼ ft., a total of 558 ft., were sunk in 26 nine-hour shifts, including all delays; the cost while at work on the property was under one dollar a

foot, but, as some of the men were brought from a distance, and their time and expenses paid while traveling, the total cost of the examination, exclusive of the engineer's fee, would exceed the amount given per foot drilled. At a copper property in Arizona, using Keystone drills for prospecting, the following cost per foot was given: over 4000 ft. were drilled during the month, an average of 14.65 ft. per drill per shift; total cost $2.09 per foot, which included 24c per foot depreciation charge.

Empire Hand Drill.

**Cost of Drilling*.—With labor at $1 per day and a horse at $1 per day, and ground from 30 to 50 ft. deep, the actual drilling costs 12 to 20c per foot. In frozen ground 25 ft. deep, 2 ft. per hour can be averaged, and recent work in Siberia has shown that this has been done there with an inexperienced crew for 23c per foot. In Idaho, with 6 ft. of snow on the ground, and half the time spent in shoveling snow away from the drilling places, the thermometer at times 25° F. below zero, and labor at $3.50 per shift, drilling was done at the rate of 37½ ft. per day of 8 hours and at a cost of 65c per foot. At another place in Idaho, ground 15 ft. deep, labor $2.50 per day, with four men and one horse, an average of 42 ft. per day was made at a cost of less than 27c per foot. In South America, ground 19 ft. deep, labor 50c per 9-hour day, and eight men, an average of 22 ft. per day at a cost less than 19c per foot was obtained. In Siberia, with 30 ft. ground, in parts frozen, labor 75c per 10-hour day, with nine men and a horse, the average rate per day was 32.5 ft. and the cost 25c per foot In Colorado, ground 18 ft. deep, labor $2 per 10-hour day, with five men and a horse, an average of 51 ft. per day at a cost of 25c per foot has been noted.

An engineer in Alaska using the Empire drill has furnished the following figures. In this work two men and a horse besides the engineer were employed. One man was paid $8.50 per day, the second $6.50 and the horse cost $5; making the total of $20 per day aside from the engineer's time. The material drilled was fine gravel unfrozen, and the holes averaged

*'A. B. C. of Empire Drilling,' by J. P. Hutchins and N. C. Stines, *Mining and Scientific Press*, January, 1911.

16 to 20 ft. in depth. The drill averaged 23 ft. per day. In Alaska experience with the hand drill in frozen ground including both Empire and other type drills has not been as successful as the operations described by Hutchins and Stines. There has been a great demand in recent years for the hand drill in examination of placers in countries where the cost of labor is low and where transportation facilities are poor and charges high and there is a good field for the hand drill in this class of work.

Examination of Title.*

The written title to a mining claim begins with the location certificate, after which the conveyances and incumbrances should appear on the abstract, as in other classes of real estate. In addition to the abstract of title, a survey and local inspection are indispensable to security, especially when the claim is not patented. The inspection and survey may show, among other things, whether the location was properly made, and more especially, if the shafts, tunnels, notices, and improvements indicate the presence of hostile claims, and, if such are found, their seniority or juniority should be established. The abstract (at least until patent) may show a clear chain of title, and may be based on a record senior to other records on the same vein, and still the title may be absolutely worthless. Whether the annual labor has been done should also be ascertained. The abstract should be certified by the recorder, or by some reputable abstract firm, to contain all deeds and instruments filed or recorded, in the office of the recorder, conveying, encumbering, or in any manner affecting title to the property in question. The abstract, however, amounts to nothing more than a guide or memorandum to the attorney in his examination. Each deed, and other instrument, should be inspected at length, either by the original, by the record, or by a certified copy. The abstract should be furnished by the vendor at his own expense.

Where the property is not patented, it would be advisable for the engineer to state whether he has examined the public records to ascertain if there are conflicting locations, also that he has made an examination of the claims so as to ascertain if there is any such conflicting location that the record might not clearly show.

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*Morrison's Mining Rights, 12th Edition.

Blank Forms.

Blank forms for deeds, leases and other legal documents are for sale in most mining centres, but for the benefit of those to whom such blanks may not be available, the following standard forms are given.

DEED.

THIS INDENTURE, Made the..day of
....................A. D. 19

BETWEEN ....

....

....

....

.....................................the part....of the first part, and

....

....

....

....

....the part....of the second part,

WITNESSETH: That the said part....of the first part, for and in consideration of the sum of..Dollars, lawful money of the United States of America, to..........in hand paid by the said part....of the second part, the receipt whereof is hereby acknowledged, ha....granted, bargained, sold, remised, released, and forever quitclaimed, and by these presents do....grant, bargain, sell, remise, release and forever quitclaim, unto the said part....of the second part, and to..........heirs and assigns, all the following described real estate, situate in.......................mining district, county of................. ......, State of....................... to-wit: (Here follows description.)

....

....

....

....

....

....

Together with all and singular the mines, minerals, lodes and veins within the lines of said claims and their dips and spurs, and all dumps, plant, fixtures, improvements, rights, privileges, and appurtenances thereunto in anywise belonging.

To have and to hold the lands, tenements and hereditaments hereby conveyed unto the said part....of the second part, ...heirs and assigns forever.

IN WITNESS WHEREOF, the said part....of the first part ha....hereunto set......hand....and seal....the day and year first above written.

Signed, Sealed and Delivered in the Presence of	..................................SEAL
	..................................SEAL
....	..................................SEAL
	..................................SEAL
....	..................................SEAL

MINING LEASE.*

THIS INDENTURE, Made this ....day of ...., in the year of our Lord one thousand nine hundred and ......, between................, of............., lessor, and..............., of................, lessee;

WITNESSETH:

That the said lessor, for and in consideration of the royalties hereinafter reserved, and the covenants and agreements hereinafter expressed, and by the said lessee to be kept and performed, granted, demised, and let, and by these presents grant, demise and let, unto the said lessee, all the following described mine and mining property, situated in ....mining district, county of.................................... of .... to-wit:

(Insert Description of Property)

Together with the appurtenances to have and to hold unto the said lessee for the term of...............from the date hereof, expiring at noon on the...... day of................, 191 , unless sooner forfeited or determined through the violation of any covenant hereinafter against the said tenant................ reserved.

And in consideration of the said demise the said lessee does covenant and agree with said lessor as follows, to-wit:

To enter upon said mine or premises and work the same mine fashion, in manner necessary to good and economical mining, so as to take out the greatest amount of ore possible, with due regard to the development and preservation of the said premises as a workable mine, and to the special covenants hereinafter reserved.

(Here insert Special Conditions and Agreements of Lease, Work to be Done, Etc.)

WORKING BOND.

A lease and option, also known as a working bond, is perhaps one of the most usual and preferable forms of sales. At the end of the mining lease just outlined, and just preceding the final paragraph, proceed as follows: And in consideration of the foregoing lease and the expenditures to be made thereunder and the well and faithful keeping of the covenants thereof, the said lessee, shall have the right to purchase the said premises, together with all improvements, etc., for the sum of...................Dollars ($........), to be distributed in the following payments: On or before the........day of .... 191... the sum of....................to be paid (designate manner and place of payment), and on or before the........day ....19.. , the sum of .... (Here insert conditions of payment.)

Time being of the essence of this contract as to such payments, and upon the tender of such payments the lessor will execute, acknowledge and deliver at his own cost, good and sufficient deeds to the lessee, or such person or company as the lessee shall nominate, conveying the said premises clear of incumbrance. (Arrangements are generally made placing deeds to the property in escrow with some bank or responsible parties to whom payments are made when due under the agreement and who delivers the deeds to the purchaser when payments are completed.)

The forfeiture, surrender or termination of the above lease for any cause shall render the option void and the above mentioned payments may not thereafter be tendered.

It is expressly agreed and understood that this Agreement shall be considered as an option to purchase only, and not as obligating the said lessee to purchase said property.

In witness whereof, etc.

To be signed, witnessed, sealed and acknowledged before a Notary or other proper commissioner to meet the requirements of the State or Country in which the property is situated.

Provisions for recording should also be observed.

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*From Morrison's Mining Rights. 12th Edition.

As it is sometimes found necessary or advisable that property adjoining that under examination be taken up, the following method of procedure in making a location and laws of the different states governing same are given:

LOCATION.*

R. S. 2320. "No location of a mining claim shall be made until the discovery of the vein or lode within the limits of the claim located."

Locations cannot lawfully be made or perfected to patent for purposes foreign to those of mining and the development of mineral. Formerly many locations were made to hold ground containing springs, or good for grazing, power sites, timber, etc. Under the present rigid field examination before approving the entry for patent such 'bluff' locations cannot be patented though they may remain as locations until the interests of public policy or the protest of some one with a better right to the land causes their removal.

No locations can be made upon Indian reservations unless allowed by a specific act of Congress; military reservations and national parks come under the same head as Indian reservations.

Locations can be made within Forest Reserves, or the National Forests with the same freedom that any public land lawfully can be entered upon for that purpose.

The land-withdrawal law passed by Congress June 25, 1910, now permits mineral locations upon withdrawn areas as follows: *"Sec. 2: That all lands withdrawn under the provisions of this act shall at all times be open to exploration, discovery, occupation and purchase, under the mining laws of the United States, so far as the same apply to minerals other than coal, oil, gas and phosphates. Provided that the rights of any person, who at the date of any order of withdrawal heretofore or hereafter made is a bona fide claimant of oil or gas-bearing lands and who at such date is in diligent prosecution of work leading to discovery of oil or gas, shall not be affected or impaired by such order as long as such occupant or claimant shall continue in diligent prosecution of such work.* * * * *."

In marking locations the usual method of staking or monumenting is to use stakes, preferably similar to patent stakes, though usually they are undressed posts cut from saplings and placed in a mound of earth and rock. Well-blazed trees, squared sapling trunks or mounds of stone are good, or a single large boulder may be marked to indicate it is a corner. The best monument consists of a pile of stones carefully laid up with a post three or four inches square or in diameter, and five or six feet long placed in the centre. Each post should be marked preferably, and have cut into it the name of the claim, and the number of the corner. Marking the lines by blazes or brushes cutting is excellent.

HOW TO LOCATE A CLAIM.

While the requirements of some states differ from others, the different state statutes have been gathered into the following list:

1. Name of lode or claim. 2. Name or names of locators. 3. Date of location. 4. Length of claim on each side of discovery or location monument. 5. Width of claim on each side of discovery or lode or centre line. 6. Course of lode or centre line. 7. Reference to natural object or permanent monument that will identify the claim. 8. Location and description of each corner. 9. Name of mining district, county and state. 10. Intention to locate as a mining claim (New Mexico only). 11. Affidavit of citizenship, familiarity with the ground, and that none is claimed adversely, and that discovery work has been performed (Idaho only). 12. Distance and direction from discovery monument to natural object or permanent monument (Idaho only). 13. Verify location notice as an affidavit (Montana only). 14. Dimensions and location of discovery work (Nevada only). 15. Affidavit of performance of the discovery work (Oregon only). 16. Reference to quarter section or section corner if upon surveyed land (Wyoming only).

*(Abstract from 'Mining Law for the Prospector, Miner and Engineer,' by H. W. MacFarren.)

The following is a good brief, comprehensive form of a location certificate, and contains the first nine requirements to which should be added any of the additional seven requirements which may be necessary.

Lode Mining Claim Location.—I have this tenth day of July, 1910, located the Exchequer Lode Mining Claim on this ground, claiming 1500 ft. in length along an easterly and westerly lode line through this discovery, and 300 ft. on each side of same as follows:

Beginning at this discovery point and monument and running easterly 500 ft. along lode or centre line to the east centre end line stake—Corner No. 1—then southerly 300 ft. to the southeast corner stake—Corner No. 2—thence 1500 ft. westerly to the southwest corner stake—Corner No. 3—thence 300 ft. northwesterly to the west centre end line stake—Corner No. 4—which is 1000 ft. westerly along the lode or centre line from discovery, thence 300 ft. northerly to the northwest corner stake—Corner No. 5—thence 1500 ft. easterly to the northeast corner stake—Corner No. 6—thence 300 ft. southerly to the east centre end-line stake—Corner No. 1; all corners being wood posts set in stone monuments, and inscribed with name of this claim and their number and position.

This claim lies about one-half mile south of the Greely claim, survey No. 4876, and on the north side of Red mountain near its foot in the Calico Peak Mining District, San Bernardino county, California. It joins on the west end-line of the May Tay claim, and on the north side of the Greenwater.

JOHN D. STRANGE, *Locator.*

The location notice may be written on a board or paper and tacked to a post or tree. The better way is to put the notice in a box or tin can turned upside down to prevent entrance of rain, and set in a conspicuous place on the rock monument. If a post be used the can should be nailed to the post in an upside-down position.

Millsite Location.—R. S. 2337. Where non-mineral land, not contiguous to the vein or lode is used or occupied by the proprietor of such lode for mining or milling purposes, such non-adjacent surface ground may be embraced and included in an application for a patent for such vein or lode, and the same may be patented therewith, subject to the same preliminary requirements as to survey and notice as are applicable to veins or lodes; but no locations hereafter made of such non-adjacent land shall exceed five acres, and payment for the same must be made at the same rate as fixed by the chapter for the superficies of the lode. The owner of a quartz mill or reduction works, not owning a mine in connection therewith may also receive a patent for his millsite as provided in this section.

Placer Location.—R. S. Sec. 2329. Claims usually called placers including all forms of deposits excepting veins of quartz or other rock in place shall be subject to entry and patent under like circumstances and conditions, and upon similar proceedings, as are provided for vein or lode claims; but, where the lands have been previously surveyed by the United States, the entry in its exterior limits shall conform to the legal subdivisions of the public lands.

R. S. Sec. 2331. Where placer claims are upon surveyed lands and conform to legal subdivisions, no further survey or plat shall be required and all placer mining claims located after May 10, 1872, shall conform as near as practical with the United States system of public land surveys, and the rectangular subdivisions of such surveys, and no such location shall include more than 20 acres for each individual claimant; but, where placer claims cannot be conformed to legal subdivisions, survey and plat shall be made as on unsurveyed lands. * * * *

The maximum size claim that one person may locate is 20 acres. Association claims may be taken up by a group or association of two or more persons on which the claim may be enlarged 20 acres for each individual in the association up to the limit of 160 acres. Two people may locate 40 acres in one claim, five may locate 100 acres, or eight or nine may locate 160 acres. A man may secure the power of attorney of seven of his acquaintances and locate a number of 160-acre claims for, as with lode locations, there is no limit under the federal statutes as to the number of claims one may locate. Association claims located for a single individual are however invalid. A single discovery is sufficient to validate a 160-acre or smaller claim, and the annual labor expenditure of $100 will hold an association claim just the same as a 20-acre claim. Likewise with patent requirements.

Placer claims upon unsurveyed land should be staked at each corner and while on surveyed land, the land department will accept for patent without staking, it is considered better practice that staking should be done and the miner take no chances. A location notice should be posted as in lode claims.

AMENDED LOCATION NOTICE.*

The following form of an amended notice or certificate of location of lode mining claim should be modified to comply with the state laws or local rules in the state or district where the claim may be situate; but the paragraph next to the last will apply and should be inserted in every amended certificate, notice, or declaratory statement of location.

Know all men by these presents, That the subscriber, James Hill, does hereby make and file this, his amended and additional certificate of location upon the Lone Share mining claim, claiming and locating, by right of original discovery and this amended and additional location certificate, three hundred feet in width on each side of the centre of said lode at the surface, and all lodes, veins, and ledges within the lines of said claim, with all their dips, variations, spurs, and angles, claiming and locating fifteen hundred feet, linear and horizontal measurement, on said lode, said lode running south three degrees six minutes east, fifteen hundred feet from the north centre end monument thereof. Said claim is more particularly described in the field-notes hereinafter set forth, to-wit:

Said lode mining claim is situated upon ...., in the .... mining district in the county of ...., in the state of ....

This is the same lode and claim of which the original notice or certificate of location was recorded January 20th, 1905, in book 40, at page 10, mining records, in the office of the .... recorder of said ....

The name of said lode claim is the "........".

This amended and additional location is made and filed without waiver of any previous right or rights acquired, made and secured under said former location, for the purpose of correcting any errors or error in said prior location, descriptions, or record, and making more specific the boundaries and descriptions of said claim, and for the purpose of acquiring and holding any overlapping, abandoned, or forfeited claim or vacant ground.

Date of this amended location and of this certificate is this first day of October, 1910.

....*Locator.*

NOTICE OF RIGHT TO WATER.

The undersigned claims the water running in this .... stream to the extent of .... inches for mining purposes to be conveyed by (ditch or flume) from this point to the .... placer claim.

Dated ...., 19—. ....

Locator.

NOTE.—This notice is to be posted near the outlet, and the following form is to be duly recorded in the district or county recorder's office.

PRE-EMPTION OF RIGHT OF WAY FOR DITCH AND LOCATION OF WATER.

To whom these presents may concern, know ye, that I .... of the county of ...., in the state of ...., a citizen of the United States, do hereby declare and publish as a legal notice to all the world, that I claim, and have a valid right to the occupation, possession and enjoyment of all and singular, that tract or parcel of land lying and being in the county of ...., in the state of ...., for the exclusive right of way for the purpose of con-

* 'Martin's Mining Law.'

structing a flume or water ditch from .... stream to .... placer claim, more particularly described as follows: Commencing [*here describe the exact route for ditch or flume.*]

I also claim, and have a valid right to the enjoyment and use of .... inches of water from said stream for mining purposes, to be conveyed through such flume or water ditch to said claim, together with all and singular, the hereditaments and appurtenances thereunto belonging, or in anywise appertaining.

Witness my hand and seal this .... day of ...., A. D. 19—.

....
[*Name.*]

Notice posted on the stream ...., 19—.
Ditch commenced at claim or at stream ...., 19—.
.... *of* .... *County of* ...., *ss.*

On this .... day of ...., 19—, before me, a ....in and for the county aforesaid, in the state aforesaid, personally appeared ...., to me personally known to be the person who executed the foregoing written instrument, and acknowledged that he executed the same for the uses and purposes therein set forth.

Witness my hand and official seal. ....

ESCROW AGREEMENT.

The enclosed deed of the .... lode is hereby placed in the .... Bank of .... *in escrow.* If A. B. shall place, or cause to be placed to the credit of C. D. and E. F., in said .... bank of ...., on or before ...., 19—, the full sum of .... dollars, then and in that case the said bank is hereby authorized to deliver the inclosed deed to A. B., or his order. In case the said A. B. shall not place, or cause to be placed, to the credit of said C. D. and E. F., in said bank, the full sum of .... dollars, on or before ...., 19—, then the said bank is hereby authorized to deliver the inclosed deed to the said C. D. and E. F., or their joint order.

(Signed) C. D.
E. F.
A. B.

...., 19—, (Place and date).

NOTE.—When the option for the purchase of a mine is desired by a third party, it is safest and best plan for the mine owner to put a deed *in escrow.* It saves incumbering of the record, and any questions that might arise concerning the payment of money. The deed should be a warranty, quit-claim, or mining deed, as agreed, fully executed and acknowledged, ready for delivery, put in a sealed envelope and placed in some bank, or left with some responsible person, with an agreement written upon the envelope, as above.

Miscellaneous Suggestions and Information.

Classification of Igneous Rocks.*

A. GRANULAR ROCKS.

Relatively coarse; crystals of constituent minerals easily visible to the naked eye, and all of about the same size.

1. *Granitic Rocks.*—Color gray, reddish, or greenish. Relatively light in color and weight. Quartz abundant, while dark minerals (hornblende, mica, pyroxene, etc.) form only a small portion of the rock. Mica apt to be more abundant than in other granular rocks. Forms of mineral grains in general short and blunt. Chief constituent minerals, quartz, feldspar, mica, hornblende.

2. *Dioritic Rocks.*—Of medium dark color and medium weight; mottled, generally green, rocks. Quartz scarce or absent; dark minerals (especially hornblende) fairly abundant. Mica may be present, but is generally less in amount than other dark minerals. Pyroxene may occur. Grains of individual minerals have a tendency to elongated forms, though they may be short. Constituent minerals, feldspar, hornblende, mica.

3. *Diabasic Rocks.*—Very dark and heavy, green of various shades, often black. No quartz, and a very large proportion of dark minerals. Mica almost always absent. Pyroxene is usually very abundant, and there is often olivine and hornblende. Magnetite in small grains (usually invisible to the naked eye) is nearly always present. Crystal forms generally elongated. Chief constituent minerals, feldspar, pyroxene, olivine.

4. *Peridotitic Rocks.*—Color, very dark green or black, darker and heavier than any of the foregoing. Are distinguished by the absence of feldspar. Often contains considerable quantities of the metallic minerals (such as magnetite, pyrrhotite, ilmente, etc) in small grains. Chief constituent

*From 'Geology Applied to Mining,' by J. E. Spurr.

minerals, olivine, pyroxene, and hornblende. Any one of these, or any two, may in some cases be entirely lacking, leaving the rock composed essentially of two of the above-named minerals, or even one.

B. COARSE PORPHYRITIC ROCKS.

Are spotted with well-formed crystals of the common rock-forming minerals, quartz, feldspar, mica, hornblende, pyroxene, etc., which are contained in a ground mass composed of interlocking crystals of markedly smaller size than the porphyritic crystals.

1. *Granitic Porphyry.*—Combines the coarse porphyritic structure with the same physical and mineralogical characters as the granitic rocks, as defined above. Chief constituent minerals, quartz, feldspar, mica, hornblende.

2. *Dioritic Porphyry.*—Combines the coarse porphyritic structure with the same physical and mineralogical characters as the dioritic rocks, as described above. Chief constituent minerals, feldspar, hornblende, mica.

3. *Diabasic Porphyry.*—Combines the coarse porphyritic structure with the same physical and mineralogical characters as diabasic rocks, as described above. Chief constituent minerals, feldspar, pyroxene, olivine.

C. FINE PORPHYRITIC ROCKS.

Like the coarse porphyritic rocks, but the groundmass is finer, so that the individual crystalline grains in it are barely or not at all visible to the naked eye.

1. *Rhyolitic Rocks.*—These are chemically and mineralogically the same as the granitic rocks and the granitic porphyry rocks, but differ in having the fine porphyritic structure. Rhyolitic rocks are generally of light color (white, light gray, pink, red, etc.) and of relatively light weight. As porphyritic crystals they generally show quartz, hexagonal in cross-section, and frequently short, blunt feldspar. Crystals of dark mica are usual, and often also hornblende; but the amount of dark minerals is relatively small. The groundmass is generally rather rough to the touch, and looks and feels somewhat

like broken coarse earthenware; the individual grains in it a usually not distinguishable. Chief constituent minerals, quar feldspar, mica, hornblende.

2. *Andesitic Rocks.*—These are chemically and mineralo cally the same as the dioritic rocks and the dioritic porphy rocks, but differ in having the fine phorphyritic structure. color the andesitic rocks are dark gray, medium brown, da red, etc. They are of medium weight. Quartz is usua not found as porphyritic crystals, and mica is not as comm as in rhyolitic rocks. The porphyritic crystals are most a to be feldspar and hornblende, often pyroxene. Dark mi erals in general are rather abundant. Groundmass genera slightly coarser than with the rhyolitic rocks; the individu grains, though they may be tiny, are often visible either to t naked eye or through a hand-lens. Chief constituent minera feldspar, hornblende, pyroxene, mica.

3. *Basaltic Rocks.*—These are chemically and mineralo cally the same as diabasic rocks, and the diabasic porphy rocks, but differ from them in having the fine porphyr structure. The porphyritic crystals are generally few, and not differ so markedly in size from the groundmass cryst as in the rhyolitic rocks and the andesitic rocks. The grou mass is generally coarser than in the andesitic and rhyol rocks; the individual grains in it though fine, can often seen by the naked eye. If they cannot, there are very lil no porphyritic crystals to be seen. Basalts contain as a no quartz or mica. They are usually black in color and he Where minerals can be distinguished in them, they are usu pyroxene, feldspar, or olivine. Chief constituent mine feldspar, pyroxene, olivine.

The foregoing classification embraces nearly all the name igneous rocks necessary to a miner, but the following na are in frequent use, and may properly be mentioned:

Granite porphyry is the same as a quartz porphyry.

Syenite is a granite without quartz; like granite it h light color, and is of relatively light weight, contains relat small amounts of the dark colored minerals, and is apt to tain mica. It is not always easy to distinguish syenite diorite in hand specimens.

Trachyte was formerly a much-used term with geolo and is still popular with miners. True trachyte bears the relation to syenite as rhyolite does to granite. It has the

chemical and mineralogical composition of syenite, but with the fine porphyritic structure. It is therefore a rhyolite without quartz.

Gabbro is a term applied to certain granular rocks consisting chiefly of feldspar and pyroxene. It thus falls within the group of diabasic rocks in the foregoing classification.

Greenstone is a general name for fine-grained igneous rocks of a general dark green color, which are generally diabase or diorite, though some times andesite and basalt. The term is admissible and of easy application.

Pegmatite or giant granite is a name applied to coarse-grained granitic dikes.

Serpentine is a rock consisting partly or wholly of the dark green greasy feeling mineral, serpentine. It is a metamorphic or altered rock derived in many cases from peridotitic igneous rocks. The decomposition of the olivine and pyroxene of peridotitics usually affords serpentine.

Breccia (brek-she-ah) resembles a conglomerate in being composed of coarse fragments packed together, but in the former the pieces are sharp and angular, and in the latter rounded by water action, indicating their origin.

SPECIFIC VOLUME OF ROCKS AND MINERALS.

	Weight per cu. ft.	Cu. ft. per ton of 2000 lb.
Quartz	165.62	12.07
Andesite	165.62	12.07
Granite	162.62	12.30
Diabase	181.25	11.03
Diorite	171.87	11.63
Dolomite	178.12	11.23
Slate	162.62	12.07
Sandstones	162.50	12.30
Rhyolite	156.25	12.80
Arsenical pyrites	371.87	5.37
Calcopyrite	262.50	7.61
Bornite	321.87	6.21
Malachite	247.50	8.04
Azurite	237.50	8.42
Chrysocolla	132.50	15.09
Magnetite	375.62	6.33
Hematite	306.25	6.53
Pyrite	312.50	6.40
Galena	468.75	4.27
Cinnabar	531.25	3.76
Zinc-blende	253.12	7.90
Tin oxide	418.75	4.77

Example: To find the number of cubic feet per ton of an ore containing 94% quartz, 4% iron pyrite, 2% galena:

Quartz	0.94 x 12.07 = 11.34
Pyrite	0.04 x 6.40 = 0.25
Galena	0.02 x 4.27 = 0.08
	11.67

Making allowance for porosity, this ore may be considered to occupy 12 to 13 cu. ft. of space per ton.

Study of Ore Deposits.*

The most evident result of mechanical stresses on rock-masses is the formation of fractures or fissures, which when mineralized may form veins. These fissures in general are, strictly speaking, fault-fissures, though the displacement is often so slight as to be imperceptible. On the other hand, large structural faults are not often found to be mineralized sufficiently to form orebodies.

The direction of fissure planes, in dip and strike, and their relation to the general joint or fissure-systems of the region should be determined. Find out whether there has been more than one period of fissuring; whether one set of veins crosses and throws another. Here caution is necessary, for there may be an apparent throw produced by contemporaneous fracturing.

In character the fissure may be a single strong break, or a combination of parallel fractures which may be sufficiently numerous to constitute a shear-zone. In the case of the single fissure the vein material is more likely to be the filling of an open space and to be enclosed within well defined walls. Cross-cuts in either wall should be examined to see whether the supposed wall is actually the lateral limit of mineralization, or if there are not mineral-bearing fissures behind it. There may be nothing that one could strictly call a vein along the zone of fracture; simply a shattering of the rock and an impregnation or replacement by silica or vein minerals. This is likely to occur in silicious rocks. Not infrequently there has been a first intrusion of igneous rock in dike form along such a fracture and subsequent movement within the dike which is usually so decomposed in the vicinity of the orebody as to be little more than a mass of clay. Such occurrences require following out along the strike to some less altered region and the detailed study of intersections for a determination of actual relations.

What the miner calls a 'chimney' of ore—a body of rudely circular cross-section—is apt to be difficult to characterize. Sometimes it is a fairly solid mass of metallic minerals; sometimes the ore simply forms the cement for breccia fragments of country rock, in either case largely by replacement. This

*Abstract from article in *Mining and Scientific Press*, July 6, 1907, by S. F. Emmons.

can generally be accounted for as zones of more or less shattered rocks at the intersection of two or more fracture planes.

The country rock has some influence on the character of the vein fissures. Where it is a homogeneous mass the vein systems are likely to be regular; but in passing from one rock to another the character of a given fissure may change. The character of such changes should be noted. In passing from a rigid rock to a plastic one a wide vein may pinch to a mere crack.

Because of their solubility the channels that admitted the solutions to rocks like limestone are often difficult to trace; the ore is more likely to be a replacement than a cavity filling. Cases do occur where it is the filling of well-defined fissures, and occasionally of open caves. Where large bodies of igneous rock have been intruded through or across limestone beds and mineralization has ensued, caught-up fragments of limestone wholly or partly enclosed in the igneous rock are often so completely replaced by ore that no limestone can be found. One may detect, however, some relics of the rock structure or some of the lime silicate minerals into which the limestone has been transformed. Where there has ben faulting near the contact of limestones and igneous rocks, mineralization often takes place in the fault material; interstices are filled and limestone fragments replaced. Finally, there are ore deposits in limestone in the vicinity of large masses of crystalline eruptives where no related fracturing or joint systems can be traced. Such orebodies are extremely irregular in form and have no definite boundaries; they are often crossed by dikes of eruptive rock that are neither mineralized themselves, nor have appreciably disturbed the orebodies.

If one has occasion to examine a mine with extended workings he should first study the map of these workings and endeavor to form some idea of the underground structure from such trustworthy information as may be given. He should take into the mine with him a map of the drifts he has to examine, or a rough reduction thereof made in his notebook. In his journeys through the mine, let him note upon this map a rough approximation of the structure and of the bearing upon it of the phenomena observed. Thus, he will often be able to decide where the critical points lie and to settle the question by construction of cross-sections from accurately measured data.

Representative Costs.

MINING COSTS.

In order to check estimates it is well to have in mind results actually attained in practice. In the table on page 43 will be found the actual costs at a number of large American gold-silver mines. In using these figures it should be noted that in each case production is on a large scale and the properties have run long enough to secure the benefit which comes from operating a going concern and direct comparison can not be made with small or new properties.

Working costs are a matter of evolution and it cannot be expected that any property, during the initial stage of its operation, will get the best results. When estimating the costs, using the costs attained at some other property where the conditions are similar, but which has been operating for a period of years, allowance must be made for higher costs during the first years of operation.

COST OF MILLING.

The cost of concentration depends very largely upon the size of the mill and the fineness of crushing required. For a fifty-ton mill, coarse crushing, the ore may be concentrated at about an average cost of $1 a ton; fine crushing, $1.50. A 100-ton mill, 75c for coarse and $1 a ton for fine crushing.

The amount of water required for a concentrator mill may be estimated at 1,000 gal. per ton of ore treated per day. For a 100-ton plant, about 100,000 gal. of water will be ample; in cases of necessity, where water is scarce, 50,000 gal. will suffice when the water is conserved. At the Goldfield mill where the water cost is 50c per 1,000 gal. the total water consumption has been reduced to 220 gal. per ton milled which is the lowest water consumption on record for such a plant. At Tonopah mill practice in general is about one ton of water per ton of ore. At the Pittsburg Silver Peak mill the daily consumption of water is about 350,000 gal. per 24 hours. The

REPRESENTATIVE MINING COSTS.

Name	Location	Treatment	Tons	Total Yield	Total Profit	Yield per Ton	Cost per Ton	Profit per Ton	Period
Tomboy..........	Colorado	Amalgamating Concentrating	110,560	$ 816,365	$ 285,982	$7.38	$4.80	* $2.58	1910.
Mont. Tonopah....	Nevada	Concentrating Cyaniding	50,245	650,405	134,715	12.94	10.26	2.68	1910.
Oriental Con.......	Korea	Amalgamating Concentrating Cyaniding	319,885	1,434,494	646,167	4.51	2.49	2.02	1910.
Camp Bird........	Colorado.	Amalgamating Concentrating Cyaniding	556,518	16,520,644	a. 10,791,339	29.66	10.28	19.38	1902–1910.
Liberty Bell.......	Colorado	Amalgamating Concentrating Cyaniding	b. 133,889	702,834	c. 282,147	X. 7.17	5.27	1.90	1910.
Alaska Treadwell...	Alaska	Amalgamating Concentrating	10,741,036	26,141,880	d. 11,867,264	2.43	1.32	1.11	1890–1910.
Homestake........	S. Dakota	Amalgamating Concentrating Cyaniding	1,237,381	4,498,751	f. 787,160	3.63	g. 2.87	0.76	1910.
Goldfield Con......	Nevada	Amalgamating Concentrating Cyaniding	266,867	10,273,934	7,347,691	38.50	e. 10.96	27.53	1910.

* Exclusive of boarding house profit, rents, etc., which were $22,355.
a. Total dividends $6,270,000.
b. Tons milled, 134,373.
X. Not including boarding house and other profits of 21c per ton.
c. Including profits from boarding house, tramway and investments.
d. Dividends paid, $11,335,000.
e. Gross expense of company including mining, milling, transportation, general expense, restoration of mill following disastrous fire, and installation of system for fire protection.
f. Including foundry and other profits.
g. Operating costs were $2,246, and other expenses including hydroelectric installation, amounted to $0.626 per ton.

water at this plant is pumped a distance of three miles against a head of 600 ft. at a cost of 7.2c per ton of ore for water used. The pumping plant requires an average of about 70 horse power which costs $6.50 per horse-power month. The mill has 100 stamps and an approximate average daily capacity of 450 tons.

The power required to operate a concentration mill should be calculated from the units which go to make up the mill. It is sometimes necessary to roughly estimate the power required in advance of the preparation of the mill plans. In this case, figure that a mill of from 50 to 100 tons daily capacity will require 1½ h.p. to treat each ton; from 100 to 200 tons capacity, about one h.p. per ton.

NOTES ON STEAM SHOVEL WORK.

Based on 8 Hour Day.

Size of Shovel Tons	Size of Dipper Yds.	Coal Consumed, Tons	Water Consumed, Gal.	Material Handled	Nature	Capacity 8-hour Day, Cu. yd.
35	1¼	.6	1200	Gravel	Common	630
				Rock	Small	378
				"	Medium	315
				"	Slaby	150
45	1½	.8	1600	Gravel	Common	756
				Rock	Small	453
				"	Medium	378
				"	Slaby	190
55	1¾	1	2000	Gravel	Common	878
				Rock	Small	526
				"	Medium	438
				"	Slaby	225
65	2	1.2	2400	Gravel	Common	1008
				Rock	Small	604
				"	Medium	504
				"	Slaby	250
75	2½	1.6	3200	Gravel	Common	1260
				Rock	Small	756
				"	Medium	630
				"	Slaby	325
90	3	1.8	3600	Gravel	Common	1512
				Rock	Small	907
				"	Medium	756
				"	Slaby	400

Crew consists of two men with necessary trainmen, trackmen, pitman, dumpers and repair men. Capacities based on assumption that shovel is attended by two Dinkys.

COST OF STEAM-SHOVEL WORK.

The cost of steam-shovel work varies greatly under different conditions of operation ranging from 10 to 70 cents per cubic yard. At the Porphyry copper mines, the total cost of stripping and moving the surface material runs from 30 to 35 cents per cubic yard.

COST OF A PROSPECTING HOIST.

Specifications and approximate cost at shipping points of a small prospecting hoist.

The load is:

	Pounds.
Ore	1000
Bucket	310
500 ft. ⅝-in. rope	310
	1620

Average hoisting speed = 250 ft. per minute.

Theoretical horsepower required = 12¼.

Indicated horsepower in engine to handle load, allowing 25% for efficiency of gearing, 16½.

Boiler gauge pressure = 100 lb.

Initial steam pressure in hoist 85 lb.

Total Weights and prices.

	Weight, lb.	Price.
1 5 x 8 in. double engine single drum hoist	2500	$ 400
1 36-in. overhead sheave with shaft and boxes	225	25
500 ft. ⅝-in. steel wire hoisting rope	310	40
1 ⅝-in. safety hook	15	5
1 1000-lb capacity kibble bucket	250	30
1 20-h.p. locomotive fire box boiler with injector	5000	425
Steam and water piping and connections	500	75
	8800	$1000

COST OF CONSTRUCTING STAMP MILLS.

There was up to a few years ago an idea prevalent among mining men in general that stamp mills could be erected and put in running order for $1,000 a stamp. This estimate may have been correct in some cases under favorable conditions when using light stamps, but the cost of the complete stamp mill of today is considerably in excess of this figure. The following tables which were kindly furnished by Charles T. Hutchinson will enable anyone contemplating the erection of a stamp mill to figure the approximate cost of same. It is obvious that the conditions governing the costs of mill con-

ESTIMATED COST OF STAMP MILLS.

PRICES ARE BASED ON PACIFIC COAST MANUFACTURE.

Specification	5 Stamps Weight	5 Stamps Cost	10 Stamps Weight	10 Stamps Cost	15 Stamps Weight	15 Stamps Cost	20 Stamps Weight	20 Stamps Cost	30 Stamps Weight	30 Stamps Cost	40 Stamps Weight	40 Stamps Cost	60 Stamps Weight	60 Stamps Cost
Grizzlies	3'x8'		4'x10'		4'x10'		4'x10'		2—4'x10'		2—4'x10'		3—4'x10'	
	650	$30	1200	$50	1200	$50	1200	$50	2400	$100	2400	$100	3600	$150
Blake Crushers	1—6"x9"		1—6"x9"		1—8"X12"		1—8"x12"		2—8"x12"		2—8"x12"		3—8"x12"	
	4400	270	4400	270	5500	490	5500	490	11000	98C	11000	980	16500	1470
Ore Bin Gates—18x24	1		2		3		4		6		8		12	
	200	15	400	30	600	45	800	60	1200	90	1600	120	2400	180
Ore Feeders	1		2		3		4		6		8		12	
	900	75	1800	150	2700	225	3600	300	5400	450	7200	600	10800	900
Batteries—(1000-lb. stamps)	17000	1125	34000	2250	51000	3375	68000	4500	102000	6750	136000	9000	204000	13500
Crab, Track and Blocks	175	40	175	40	200	45	200	45	200	45	250	50	350	70
Plates { 1 oz. sil. / 5 lb. cop. } per sq. ft.	1—5'x12'		2—5'x12'		3—5'x12'		4—5'x12'		6—5'x12'		8—5'x12'		12—5'x12'	
	300	200	600	400	900	600	1200	800	1800	1200	2400	1600	3600	2400
Amalgam Traps	1		2		3		4		6		8		12	
	185	10	370	20	555	30	740	40	1110	60	1480	80	2220	120
Concentrators	2—4'		4—4'		6—4'		8—4'		12—4'		16—4'		24—4'	
	5600	825	11200	1650	16800	2475	22400	3300	33600	4950	44800	6600	67200	9900
Amalgam Barrel	1—18"x24"		1—18"x24"		1—24"x30"		1—24"x30"		1—24"x48"		1—24"x48"		1—24"x48"	
	1200	90	1200	90	2400	165	2400	165	3400	300	3400	300	3400	300
Retort and Furnace	1000	75	2000	150	3000	270	3000	270	5000	375	5000	375	5000	375
Shafting	3500	375	6000	630	9000	945	12000	1200	16000	1650	24000	2400	40000	4000
Belting	375	190	525	260	675	350	900	450	1350	675	1800	900	2700	1350
Water Piping	400	40	700	75	1000	110	1400	150	2000	225	2800	300	4500	480
Total	35885	$3360	64570	$6065	97530	$9175	123340	$11820	186460	$17850	244130	$23405	366270	$35195
Boilers	36"x10'		42"x12'		48"x14'		54"x16'		60"x16'		2—48"x16'		3—48"x16'	
	5000	$400	9100	$600	12000	$900	13500	$1150	16500	$1320	24000	$2000	36000	$3000
Engine	9"x12" C.&T.		11"x14" C&T		12"x16" C&T		12"x30"		12"x36"		14"x42"		16"x48"	
	3000	450	4000	630	5400	700	17000	1500	21000	1750	26000	2000	32000	2350
Feed Pump—Cameron	No. 0		No. 1		No. 2		No. 3		No. 4		No. 4		No. 5	
	160	75	250	100	300	125	500	150	550	180	550	180	960	300
Heater—National	No. 2		No. 3		No. 5		No. 6		No. 8		No. 12		No. 15	
	175	45	330	70	420	100	460	120	520	150	660	210	1000	270
Piping	560	50	650	75	750	100	1600	165	2400	250	3600	440	5600	525
Total	8895	$1020	14330	$1475	18870	$1925	33060	$3085	40970	$3650	54810	$4830	75560	$6445
Total with Power	44780	$4380	78900	$7540	116400	$11100	156400	$14905	227430	$21500	298940	$28335	441830	$41640

COST OF ERECTING STAMP MILLS

COST IS BASED ON PACIFIC COAST PRICES.

		5 Stamps		10 Stamps		15 Stamps		20 Stamps		30 Stamps		40 Stamps		60 Stamps	
Specification	Unit	Qnty.	Cost	Qnty.	Cost	Qnty.	Cost	Qnty.	Cost	Qnty.	Cost	Qnty.	Cost	Qnty.	Cost
Grading	$1 cu. yd.	400	$400	800	$800	1100	$1100	1300	$1300	1700	$1700	2100	$2100	3000	$3000
Retaining wall	$10 cu. yd.	60	600	90	900	120	1200	140	1400	185	1850	230	2300	320	3200
Battery Timber	$25 M	5000	125	10000	250	15000	375	20000	450	30000	750	40000	1000	60000	1500
Ore Bin Timber	$20 M	6000	120	12000	240	18000	360	24000	480	36000	720	48000	960	72000	1440
Building Lumber	$20 M	30000	600	60000	1200	70000	1400	75000	1500	90000	1800	105000	2100	145000	2900
Total Lumber		41000		82000		103000		119000		156000		193000		277000	
Shingles	$3 M	25	75	45	135	60	180	70	210	95	285	120	360	180	540
Windows and Doors		30	75	40	100	48	120	52	130	66	165	75	190	105	270
Bolts and Nails	5c lb.	1200	60	2500	125	3000	150	3600	180	4800	240	6000	300	8500	425
Painting			90		120		145		160		200		225		320
Millwright Labor	$4 day	370	1480	740	2960	930	3720	1070	4280	1400	5600	1750	7000	2500	10000
Superintendence			400		500		500		600		800		1000		1200
Total Cost			$4025		$7330		$9250		$10690		$14110		$17540		$24800
Boiler and Engine Room															
Grading	$1 cu. yd.	100	$100	100	$100	150	$150	200	$200	250	$250	300	$300	400	$400
Retaining Walls	$10 cu. yd.	10	100	10	100	15	150	20	200	25	250	30	300	40	400
Concrete Foundations	*do*	8	80	10	100	12	120	15	150	18	180	22	220	25	250
Common Brick	$15 M	9	135	11	165	12	180	13	195	14	210	20	300	28	420
Fire Brick	$80 M	750	60	850	70	1000	80	1400	110	1500	120	2500	200	4000	320
Fire Clay	3c lb.	350	10	400	12	500	15	700	20	750	25	1250	40	2000	60
Lime	$3 bbl.	9	27	11	33	12	36	13	39	14	42	20	60	28	84
Sand	$1.50 cu. yd.	9	14	11	17	12	18	13	20	14	21	20	30	28	42
Mason and Helper	$8 day	9	72	11	88	12	96	13	101	14	112	20	160	28	204
Setting Machinery	$3 day	30	90	40	120	50	150	65	195	70	210	85	225	100	300
Building Lumber	$20 M	6000	120	6000	120	6500	130	8000	160	9000	180	10000	200	12000	240
Shingles	$3 M	9	27	9	27	10	30	15	45	20	60	25	75	30	90
Windows and Doors		10	25	10	25	10	25	15	40	15	40	18	45	20	50
Bolts and Nails	5c lb.	200	10	200	10	250	13	300	15	400	20	500	25	600	30
Carpenter	$4 day	30	120	30	120	35	140	40	160	45	180	50	200	60	240
Total, Power Room			$990		$1120		$1330		$1650		$1900		$2410		$3130
Erection Cost, Total			$5015		$8330		$10580		$12340		$16010		$19950		$27930

struction vary greatly in different localities and that the cost statement of the construction of any given mill cannot properly be used as a criterion of construction cost in general. A complete and well-constructed mill and cyanide plant may cost as

MACHINERY SPECIFICATIONS.

	Size	Approx. H.P.	Approx. Capacity Tons per 24 hr.	Weight, lb.	Cost at Factory
Blake Crusher	6 by 9 in.	6 to 8	50 to 100	4400	$ 300
	8 by 12 in.	15 to 18	100 to 170	6000	500
	10 by 20 in.	20 to 25	250 to 300	18000	1250
Gates Crusher	No. 3	25 to 30	240 to 400	15500	1000
	No. 4	30 to 35	350 to 650	22500	1500
	No. 6	50 to 60	700 to 1250	49000	2250
10-Stamp Battery	1000 lb.	20	35 to 60	33000	2000
Wilfley Table		¾ to 1	10 to 40	3200	450
Vanner	6 ft.	½ to 1	6 to 10	3000	400
Rolls	12 by 20 in.	5 to 10	30 to 125	7100	800
	16 by 36 in.	10 to 20	50 to 200	24000	1800
Huntington Mill	3½ ft.	6	8 to 12	6000	600
	5 ft.	10	15 to 30	11000	950
Chilean Mill	6 ft.	35 to 60	50 to 75 (Regrinding from 4–30 mesh)	50000 to 60000	3750
Tube-mill	5 by 22 ft.	*80 to start 40 to operate	100 when regrinding from 20 mesh to 100 mesh 75 when reducing Chilean mill product to 50% 200 mesh	Mill 30000 Silex 6 tons Pebbles 10 tons El Oro lining 8 tons	1750 240 250 650

*3 tube-mills would require power approximating 175 to 200 h.p.

high as $10,000 per stamp. The Goldfield Consolidated mill cost almost this amount.

Among the different factors that govern cost of mill construction may be mentioned: the capacity, general design of mill and nature of ore treatment; first cost of machinery, freight and cost of transportation from the railroad; the mill site, upon which depends the cost of grading, retaining walls, etc.; cost of timber and other building material; cost of any equipment necessary for water supply; cost and efficiency of management and labor.

COST OF AERIAL TRAMWAYS.

The average cost to erect an aerial tram according to various writers is from $10,000 to $15,000 per mile but in some localities where the difficulties have been great the cost of construction has greatly exceeded this latter figure. At the San Toy mine near Chihuahua, Mexico, an aerial tramway about five miles long built in two sections with automatic loaders cost $120,000 gold. At the Pittsburg Silver Peak mine, Blair, Nevada, an aerial tramway 2¼ miles long cost $70,000. Operating costs are generally figured by manufacturers at from 3 to 5c per ton-mile. It is obvious that operating costs will vary according to conditions and capacity and in this connection the following will be of interest. At the San Toy mine the cost, including repairs but not including depreciation, was given at 21c per ton.

Operating costs Pittsburg Silver Peak tramway, 1910.

Tonnage, 173,736.	Per ton
Foreman	$0.007
Brakeman	0.014
Lineman	0.010
Conveyorman	0.019
Repairs	0.078
Lubricants	0.004
Sundries	0.002
Pro-general	0.026
Suspense	0.012
	$0.172

Tramway costs for the year 1911 at the Plumas Eureka Mines*:

Reconstruction work and repairs	$ 470.12
Material (including 6800 ft. of ¾-in. plow steel rope)	941.20
Operating cost	1425.25
Total cost of aerial tramming	$2836.57

Tonnage handled, 7,551¾.
Tramming cost per ton of ore, 37½c.
Distance covered, 3,500 ft.
Difference in altitude at stations, 22 degree angle.
Size of cables—Running rope, ¾ in. Standing rope, ⅞ in. on light side; 1⅛ in. on loaded side.
Capacity of buckets, 4½ cu. ft.
Number of buckets dumping, 23.
Power developed by tramway, 4 horsepower.

*The operating cost per ton is high for the reason that the tram was not operated at full capacity.

COST OF TRAMWAYS.

The following is an estimate of erection cost of a tramway under certain conditions. It can be modified by anyone desiring an approximation of tramway costs to suit the special conditions at the property in question.

ESTIMATE NO. 1.

Wire cables, carriers and machinery, as follows for a detachable bucket type wire-rope tramway to carry ore weighing broken 125 lb. per cu. ft.

Length of the line, 5560 ft. Capacity, 40,000 lb. hourly.

Elevation of loading above discharge terminal, 712 ft.

Capacity of carriers, 1200 lb. Speed of traction rope, 366 2-3 ft. per minute.

Distance between carriers, 660 ft.; or intervals of carriers 108 seconds.

Estimated horse-power developed, 8.

Track cables: 5600 ft. 1⅜-in. pat. locked-coil steel track cable, with patent steel couplings; 5600 ft. 1-in. pat. locked-coil steel track cable, with patent steel couplings.

Traction rope: 11,300 ft. ⅝-in. special steel traction rope, coupling and splicing tools.

Rolling stock: 22 carriages, with hangers, patent compression grips and steel buckets.

For 24 supports: 48 saddles, 48 rollers with axles and bearings, bolts and washers.

For terminals: sheaves, shafts, bearings, brakes, tension mechanism, 250 ft. shunt rails, auto. attachers and detachers, 1 spacing gong, 1 loading chute, bolts, etc., with working drawings.

Above equipment f. o. b. factory: Weight, pounds, 110,240; price, $9900.

ESTIMATE NO. 2.

Wire cables, carriers and machinery, as follows for a detachable bucket type wire rope tramway to carry ore weighing broken 125 lb. per cu. ft.

Length of the line, 5560 ft. Capacity, 40,000 lb. hourly.

Elevation of loading above discharge terminal, 712 ft.

Capacity of carriers, 600 lb. Speed of traction rope, 420 ft. per minute.

Distance between carriers, 378 ft.; or intervals of carriers, 54 seconds.

Estimated horse-power developed, 7½.

Track cables: 5600 ft. 1⅛-in. pat. locked-coil steel track cable, with patent steel couplings; 5600 ft. ⅞-in. locked-coil steel track cable, with patent steel couplings.

Traction rope: 11,300 ft. ⅝-in. special steel traction rope, coupling and splicing tools.

Rolling stock: 35 carriages, with hangers, patent compression grips and steel buckets.

For 24 supports: 488 saddles, 48 rollers with axles and bearings, bolts and washers.

For terminals: sheaves, shafts, bearings, brakes, tension mechanism, 250 ft. shunt rails, auto. attachers and detachers, 1 spacing gong, 1 loading chute, bolts, etc., with working drawings.

Above equipment f. o. b. factory: Weight, pounds, 93,700; price, $8,980.

COST OF ERECTION.

Towers, 24, range from 15 to 80 ft. in height—requiring 88,000 ft. of lumber.

Terminals—

Loading	11,000
Ore bin	8,000
Discharge	23,000
Total lumber	42,000

Figure $20 per thousand for cutting, framing, and erecting, in addition to cost of lumber. Installation of terminal machinery, 1¼c per lb. Stretching cables 2c per lb. In case of the estimate given, cables would weigh 44,296 lb., making a stretching cost of $885.

COST OF GOLD DREDGES.

The cost of a gold dredge depends, to a great extent, upon the general design of the boat and conditions under which it is to operate, such as the character and depth of the gravel, and the location of the property governing labor and transportation costs. The following figures of actual cost of different boats for California fields show how prices vary for dredges of presumably the same capacity.

3 1-3 ft. boat	$ 50,000 to	$ 65,000
5 ft. boat	70,000 to	85,000
7½ ft. boat	85,000 to	145,000
9 ft. boat		175,000
13½-15-ft. boat	225,000 to	300,000

A rough estimation of the cost of a modern California type dredge can be figured approximately at $180 per ton.

The first cost of a dredge should not be considered a matter of such vital importance by the intending purchaser as is often the case. If, by strengthening and increasing the weight of certain parts that are subjected to great strain or wear, a

saving of even 1-2 c. per cubic yard in working cost can be effected, this is obviously economical even though the first cost be increased $15,000 or $20,000, or more. Economy resulting from less loss of time for repairs, to say nothing of the greater cost of repairs for the lighter boat operating under the same conditions, will soon compensate for the increased initial outlay.

In Alaska there is a growing field for small dredges with buckets of from two to three cu. ft. capacity and costing from $25,000 to $45,000 erected. The former cost being that of a flume type dredge, the buckets dumping directly into a flume 60 or 70 ft. long which extends back of boat. It is claimed that these boats make a high percentage of recovery when handling gravel free from much clay.

OPERATING COST OF GOLD DREDGES.

While the cost of dredging varies greatly under different conditions and in different localities, and is also to a great extent a matter of bookkeeping, the following operating costs are given for what interest they may have.

Capacity of Buckets	Yardage Handled	Average Depth	Working Period	Time in Commission	Operating Expenses Cents per Cubic Yard						Operating Conditions
					Labor and Material	Power	Repairs	General	Taxes and Insurance	Total	
					CALIFORNIA.						
3	458,882	26.9	1 yr.	6 yrs.	2.03	0.69	3.28	0.63	0.37	7.00	Favorable
5	635,146	27.0	1 yr.	3 yrs.	3.14	1.45	2.40	1.28	0.41	8.70	Difficult
5	1,148,802	30.0	1 yr.	3 yrs.	0.82	0.49	1.89	0.28	0.16	3.64	Favorable
7	1,017,167	28.0	1 yr.	3 yrs.	1.10	0.65	2.19	0.53	0.14	4.51	Difficult
8	2,287,704	28.5	1 yr.	4 yrs.	1.04	0.59	1.29	0.51	0.15	3.58	Favorable
13	4,056,422	20.6	1 yr.	7 yrs.	0.55	0.39	1.00	0.37	0.09	2.40	Favorable
15	1,837,351	59.3	269 days		1.00	1.10	0.36	0.57	0.21	4.24	Difficult
					COLORADO.						
9½	1,400,544	30.0	9 m	.....	0.69	1.07	1.68	0.59	0.63	4.66	Medium
					MONTANA.						
9	1,326,573	30.0	2 yrs.	.....	2.71	*3.07	3.64	1.92	.....	11.34	Difficult
					ALASKA. (a)						
3½	230,000	11.0	4 m	1 yr.	7.	*6.	.....	6.50	.....	19.50	Favorable
4	150,000	10.0	4 m	7 yrs.	13.5	*11.5	4.3	5.70	.....	35.00	Medium

*Fuel. a. Alaska costs, approximations. Season is about 120 days.

Miscellaneous Tables and Data.

WEIGHTS AND MEASURES.

LINEAR MEASURE

12 inches = 1 foot
3 feet = 1 yard
1760 yards or 5280 ft. = 1 mile

SQUARE MEASURE

144 square inches = 1 sq. ft.
9 square feet = 1 sq. yd. = 1296 sq. inches
4840 square yds. or 43,560 sq. ft. = 1 acre
640 acres = 1 square mile

CUBIC MEASURE

1728 cu. in. = 1 cu. ft.
27 cu. ft. = 1 cu. yd.
268.8 cu. in. = 1 standard gal.
231 cu. in. = 1 U. S. gal.

TROY WEIGHT

24 grains = 1 pennyweight (dwt.)
20 dwt. = 1 oz. = 480 grains
12 oz. = 1 lb. = 5,760 grains

AVOIRDUPOIS WEIGHT

27,343 grains = 1 dram
16 drams = 1 oz. = 437½ grams
16 oz. = 1 lb. = 7000 grams

LIQUID MEASURE

4 gills = 1 pint = 16 liquid oz. = 28.876 cu. in.
2 pints = 1 quart = 8 gills = 57.75 cu. in.
4 quarts = 1 gallon = 32 gills = 231 cu. in.

CIRCULAR MEASURE

60 seconds = 1 minute
60 minutes = 1 degree
30 degrees = 1 sign
60 degrees = 1 sextant
90 degrees = 1 quadrant
360 degrees = 1 circle

METRIC MEASURES OF WEIGHT

(Unit Gramme.)

	Grains.	Oz. Troy.	Lb. Avoir.	Cwt.
Centigramme	0.15432	......	.....	.....
Decigramme	1.54323	0.003	.....	.....
Gramme	15.43235	0.032	0.002	.....
Decagramme ...	154.32349	0.321	0.022	.....
Hectogramme	1543.23488	3.215	0.220	0.001
Kilogramme.....	15432.34880	32.150	2.204	0.019

METRIC MEASURES OF LENGTH

(Unit Metre.)

	Inches.	Feet.	Yards.	Miles.
Millimetre ...	0.03937	0.003	0.001	.....
Centimetre ...	0.39371	0.032	0.010	.....
Decimetre ...	3.93708	0.328	0.109	.....
Metre	39.37079	3.280	1.093	.....
Decametre ...	393.70790	32.808	10.936	0.006
Hectometre ...	3937.07900	328.089	109.363	0.062
Kilometre	39370.79000	3280.899	1093.633	0.621

MISCELLANEOUS WEIGHTS

480 grains in 1 oz. Troy.
437½ grains in 1 oz. Av.
5760 grains in 1 lb. Troy.
7000 grains in 1 lb. Av.
14.583+ oz. Troy in 1 lb. Av.
0.91145+ oz. Troy in 1 oz. Av.
1.215 lb. Troy in 1 lb. Av.
1 oz. Troy in 1.097 oz. Av.
1 lb. Troy in 0.8228 lb. Av.
1 oz. Av. in 0.9114 oz. Troy.
1 lb. Av. in 1.2152 lb. Troy.
15.432 grains in 1 gramme.
453.6029+ grammes in 1 lb. Av.
28.35+ grammes in 1 oz. Av.
31.104+ grammes in 1 oz. Troy.
1 milligram = 0.0154 grains.
1 gramme per metric ton = 14 grains per 2000 lb. ton.
1 kilogramme per metric ton = 2 lb. per 2000 lb. ton.
1 U. S. gallon = 0.83 Imperial gallons.
1 Imperial gal. = 1.2 U. S. gal.

1 horsepower = 33,000 foot-pounds per minute = 4562.33 kilogram-metres per minute = 0.7459 kilowatt = 1.013 metric horsepower.

1 metric horsepower = 32,549 foot-pounds per minute = 4500 kilogram-metres per minute = 0.7357 kilowatt = 0.986 horsepower.

WEIGHT AND CAPACITY OF DIFFERENT STANDARD GALLONS OF WATER

	Cubic Inches in a Gallon.	Weight of a Gallon in Pounds.	Gallons in a Cubic Foot.
Imperial or English..........	277.274	10.00	6.232102
United States................	231.	8.333111	7.480519
New York	221.819	8.00	7.901285

A cu. ft. of water, U. S. standard, weighs 62½ lb.; English standard, 62.321 lb. avoirdupois.

Weight of crude or refined petroleum, 6½ lb. per U. S. gallon; 42 gal. to the barrel.

CONVERSION TABLES.

The following tables afford a very accurate and rapid means of converting Russia into British, Russian into Metric, Metric into British measurements and *vice vers*

The number to be converted is subdivided into its multiples of 1, 10, 100, &c.

On the extreme left of each table is a column of "multiples" from 1 to 9.

If the original number is Metric the equivalent value in English measurement wi be found in the English column opposite the required multiple. The actual value given are for multiples of "unity"; for multiples of "ten" use the same figures wit the decimal point moved one place to the right, &c.

EXAMPLE :—Convert 186 ft. to metres.

186 = (100 + 80 + 6) ft. = (100 × 304) + (10 × 2 438) + 1.828) m
= 30.4 + 24.38 + 1.828 = 56.608 metres.

BRITISH—METRIC LENGTH.

	In.	Mm.	In.	Cm.	Ft.	M.	Yd.	M.	Mi.	Kilo
1	.0394	25.4	.394	2.54	3.2809	.3048	1.094	.914	.621	1.609
2	.0787	50.8	.787	5.08	6.5618	.6096	2.187	1.829	1.243	3 219
3	.1181	76.2	1.181	7.62	9 8427	.9144	3.281	2.743	1.864	4.82
4	.1575	101 6	1.575	10.16	13.123	1.2192	4.374	3.658	2.486	6.43
5	.1968	127.0	1 968	12.70	16 404	1.5239	5.468	4.572	3 107	8.04
6	.2362	152.4	2.362	15.24	19.685	1.8287	6.562	5.486	3.728	9.65
7	.2756	177.8	2.756	17.78	22.965	2.1335	7.655	6 401	4.350	11.26
8	.3150	203 2	3.150	20.32	26 247	2.4383	8.749	7.315	4 971	12.87
9	.3543	228 6	3.543	22.86	29 528	2.7431	9.843	8.229	5.592	14 48

BRITISH—METRIC AREA.

Sq in.	Mm.	Sq. in.	Cm².	Sq. ft.	M².	Sq. yds.	M².	Acres.	M².
.00155	645.13	1550	6.4513	10.7643	.0928	1.1960	.8361	.0002471	4046.7
.00310	1290 3	.31001	12.902	21.528	.1857	2.3920	1.6722	.0004942	8093.4
.00465	1935.4	.4650	19 354	32.292	.2786	3.5881	2.5082	.0007413	12140.1
.00620	2580 5	.6200	25.805	43.057	.3715	4.7841	3.3444	.0009884	16186.8
.00775	3225.6	.7750	32.256	53.821	4644	5.9801	4.1804	.0012355	20233 5
.00930	3870 8	.9300	38.708	64 585	.5573	7.1762	5.0165	0014827	24280 2
.01085	4515.9	1 0850	45 159	75.350	6502	8.3722	5.8526	.0017298	28326 9
.01240	5161.1	1.2400	51.611	86.114	.7431	9.5682	6 6887	0019769	32373 6
01395	5806.2	1.3950	58.062	96 878	.8361	10.764	7 5248	.0022240	36420·3

BRITISH—METRIC VOLUME.

British Metric Volume.

Cu. in.	Cm³.	Cu. ft.	M³.	Cu. yd.	M³.	Gals.	Litres.
.0610	16.386	35 316	.0283	1.3080	.7646	.22	4.546
.1221	32.772	70 633	.0566	2 6159	1 5291	.44	9.092
.1831	49.158	105.94	.0849	3.9239	2.2937	.66	13.638
2441	65.545	141.26	.1133	5.2318	3.0582	.88	18.184
.3051	81.931	176.58	.1416	6.5498	3 8228	1.10	22.73
.3662	98.317	211 89	.1699	7.8477	4.5873	1.32	27.276
.4272	114.70	247.21	.1982	9.1557	5 3519	1.54	31.822
.4882	131.09	282.53	.2265	10.464	6.1164	1.76	36.378
.5492	147.48	317.84	.2548	11.772	6.8810	1.98	40.924

BRITISH—METRIC WEIGHT, PRESSURE.

Weight.		Volumetric Weight.		Pressure.	
Lb.	Kg.	Lb./Cu. ft.	Kgs./m³.	Lb /Sq. in.	Kg /Cm².
2 2046	.4536	.06243	16.02	14 22	.0703
4.4092	.9072	.12486	32.04	28.45	.1406
6.6139	1 3607	.18729	48.05	42 67	.2109
8 8185	1.8143	.24972	64.07	56.89	.2812
11.023	2.2679	31215	80 09	71.11	.3515
13.227	2.2721	.37458	96 11	85.36	4219
15 432	3.1751	.43701	112.13	99.56	.4922
17.637	3.6287	.49944	128 14	113.78	.5625
19.842	4.0823	56187	144.16	128.0	.6328

VALUE OF PURE GOLD.

BRITISH—AMERICAN—RUSSIA.

Based on 1 British Pound Sterling=$4.8665=Rs.9.459.

Weight			£	s.	d.	Sterling	U.S.A. Dollars	Roubles
1 Grain	=1.46 Dolis	=64.8 Milligrams =			2.124	£0.00885	$0.04306	[illegible]
1 oz. Troy	**=7.29 Zolotniks**	**=31.10 Grammes =**	**£4**	**4**	**11 4545**	**£4.24773**	**$20.6716**	[illegible]
1 lb. Avoir.	=1.11 Funts	=453.6 Grammes =	£61	18	11	£61.946	$301.46	[illegible]
1 Doli	=0.69 Grains	=44.4 Milligrams =			1.4564	£0.00607	$0.0295	[illegible]
1 Zolotnik	=2.74 Dwt.	=4.27 Grammes =		11	7.82	£0.5826	$2.8350	[illegible]
1 Funt	=0 90 Lb. Av.	=0 41 Kilograms =	£55	18	6.27	£55.926	$272.16	[illegible]
1 Pood	=36 11 Lb. Av.	=16.4 Kilograms =	£2237	0	10.7	£2237.04	$10,886.58	R21,[illegible]
1 Gramme	=15 4 Grains	=0 23 Zolotnik =		2	8.776	£0.1366	$0.6646	[illegible]

	Shillings	Pounds Sterling £	s.	d.	U.S.A. Dollars $ c.	Roubles R. k.
1 Gramme	2.73		2	8.78	.66	1.29
2 ,,	5.46		5	5.55	1.33	2.58
3 ,,	8.19		8	2.33	1.99	3.88
4 ,,	10.93		10	11.10	2.66	5.17
5 ,,	13.66		13	7.88	3.32	6.46
6 ,,	16.39		16	4.66	3.99	7.75
7 ,,	19.12		19	1.43	4.65	9.04
8 ,,	21.85	1	1	10.21	5.32	10.33
9 ,,	24.58	1	4	6.99	5.98	11.63
10 ,,	27.31	1	7	3.76	6.65	12.92
11 ,,	30.04	1	10	0.54	7.31	14.21
12 ,,	32.77	1	12	9.31	7.98	15.50
13 ,,	35.51	1	15	6.09	8.64	16 79
14 ,,	38.24	1	18	2.87	9.30	18.09
15 ,,	40.97	2	0	11.64	9.97	19.38
16 ,,	43.70	2	3	8.42	10.63	20.67
17 ,,	46.43	2	6	5.19	11.30	21.96
18 ,,	49.16	2	9	1.97	11.96	23.26
19 ,,	51.89	2	11	10.75	12.63	24.55
20 ,,	54.62	2	14	7.52	13.29	25.84
21 ,,	57.36	2	17	4.30	13.96	27.13
22 ,,	60.09	3	0	1.07	14.62	28.42
23 ,,	62.82	3	2	9.85	15.29	29.72
24 ,,	65.55	3	5	6.62	15.95	31.01
25 ,,	68.28	3	8	3.40	16.62	32.30
26 ,,	71.01	3	11	0.18	17.28	33.59
27 ,,	73.74	3	13	8.95	17.94	34.88
28 ,,	76.47	3	16	5.73	18.61	36.18
29 ,,	79.21	3	19	2.50	19.27	37.47
30 ,,	81.94	4	1	11.28	19.94	38.76
31 ,,	84.67	4	4	8.06	20.60	40.05
31.1035=1 oz	84.95	4	4	11.45	20.67	40.18

CONVERSION FACTORS

Millimetres	×	.03937	= inches.
Millimetres	÷	25.4	= inches.
Centimetres	×	.3937	= inches.
Centimetres	÷	2.54	= inches.
Metres	×	39.37	= inches.
Metres	×	3.281	= feet.
Metres	×	1.094	= yards.
Kilometres	×	.621	= miles.
Kilometres	÷	1.6093	= miles.
Kilometres	×	3280.8693	= feet.
Square Millimetres	×	.00155	= sq. inches.
Square Millimetres	÷	645.1	= sq. inches.
Square Centimetres	×	.155	= sq. inches.
Square Centimetres	÷	6.451	= sq. inches.
Square Metres	×	10.764	= sq. feet.
Square Metres	×	1.196	= sq. yard.
Square Kilometres	×	247.1	= acres.
Hectare	×	2.471	= acres.
Acres	×	0.404	= hectares.
Cubic Centimetres	÷	16.383	= cubic inches.
Cubic Centimetres	÷	3.69	= fl. drams.
Cubic Centimetres	÷	29.57	= fluid oz.
Cubic Metres	×	35.315	= cubic feet.
Cubic Metres	×	1.308	= cubic yards.
Cubic Metres	×	264.2	= gallons (231. cu. in.)
Litres	×	61.022	= cubic in.
Litres	×	38.84	= fluid ounces.
Litres	×	.2642	= gallons (231. cu. in.)
Litres	÷	3.78	= gallons (231. cu. in.)
Litres	÷	28.316	= cubic feet.
Hectolitres	×	3.531	= cubic feet.
Hectolitres	×	2.84	= bushels (2150.42 cu. in.)
Hectolitres	×	.131	= cubic yards.
Hectolitres	÷	26.42	= gallons (231 cu. in.)
Grains	×	0.065	= grammes.
Ounces (avoir.)	×	28.34	= grammes.
Ounces (Troy)	×	31.104	= grammes.
Grammes	×	15.432	= grains.
Grammes (water)	÷	29.57	= fluid ounces.
Grammes	÷	28.35	= ounces avoirdupois.
Grammes per cu. cent	÷	27.7	= lb. per cu. in.
Milligrammes	×	0.0154	= grains.
Kilo-grammes	×	15432.36	= grains.
Kilo-grammes	×	2.2046	= pounds.
Kilo-grammes	×	35.3	= ounces avoirdupois.
Kilo-grammes	÷	907.2	= tons (2000 lb.)
Kilo-gr. per sq. cent	×	14.223	= lbs. per sq. in.
Kilo-gram-metres	×	7.233	= foot lb.
Kilo-gr. per Metre	×	.672	= lb. per foot.
Kilo-gr. per Cu. Metre	×	.062	= lb. per cu. ft.
Tonneau	×	1.1023	= tons (2000 lb.)
Kilo-Watts	×	1.34	= horse power.

Watts	÷	746.	=horse power.
Watts	×	.7373	=foot pounds per second.
Calorie	×	3.968	=B. T. U.
Cheval vapeur	÷	.9863	=horse power.
Centigrade	×	1.8+32	=degree Fahrenheit.
Franc	×	.193	=Dollars.
Gravity Paris			=980.94 centimetres per sec.
Diameter of a circle	×	3.1416	=the circumference.
Circumference of a circle	×	0.31831	=the diameter.
Diameter of a circle	×	0.8862	=the side of an equal square.
Side of a square	×	1.128	=the diam. of an equal circle.
Square of diameter	×	0.7854	=the area of a circle.
Square root of area	×	1.12837	=the diam. of equal circle.
Square of the diam. of a sphere	×	3.1416	=convex surface.
Cube of ditto	×	0.5236	=solidity.
Diameter of a sphere	×	0.806	=dimensions of equal cube.
Diameter of a sphere	×	0.6667	=length of equal cylinder.
Square inches	×	0.00695	=square feet.
Cubic inches	×	0.00058	=cubic feet.
Cubic feet	×	0.03704	=cubic yards.
Cylindrical inches	×	0.0004546	=cubic feet.
Cylindrical feet	×	0.02909	=cubic yards.
Cubic inches	×	0.003607	=imperial gallons.
Cubic feet	×	0.6232	=imperial gallons.
Cylindrical inches	×	0.002832	=imperial gallons.
Cylindrical feet	×	4.895	=imperial gallons.
183.346 circular inches			=1 square foot.
2200 cylindrical inches			=1 cubic foot.

WEIGHTS OF IRON AND STEEL.

Cast iron weighs about one lb. per 4 cu. in.

Wrought iron weighs about one lb. per 3½ cu. in.

Steel weighs about 2% more than wrought iron.

To ascertain the weight in pounds per running foot of round steel, multiply the diameter in inches by 4, square the result and divide by 4, add 1%.

To find the weight of square steel in pounds per running foot, multiply the size in inches by 4, square this, divide by 5, and add 1-16.

To ascertain the weight of flat steel in pounds per foot. multiply the width in inches by thickness, multiply product by 10, divide result by 3, add 2%.

Steel boiler plate weighs approximately 2½ lbs. per square foot for each 1-16 in. in thickness.

Copper plate weighs 2.83 lbs., and brass 2.7 lb. per square foot for 1-16 in. in thickness.

To find the number of tons of rails per mile of road, multiply weight of rail per yard by 11, and divide by 7. This does not include sidings. A ton is reckoned as 2240 lb., as rails are regularly sold by this weight.

AMOUNT OF MATERIAL REQUIRED FOR BUILDINGS.

Shingles.—250 to 1 bundle. 4 bundles equal 1,000 shingles, will cover 100 sq. ft. of surface, laid 4 in. to the weather.

1 bundle of 16 in. shingles will cover 30 sq. ft., while the same number of 18-in. shingles will cover 33 sq. ft. when laid 5½ in. to the weather.

Lath.—1,000 laths will cover 70 sq. yd. of surface.

Shakes.—1,000 shakes, 6 in. by 36 in., laid 16 in. to the weather, will cover 650 sq. ft. of surface; add for doubling top and bottom courses one extra shake for each foot in the length of roof.

Corrugated Galvanized Roofing.—Size of sheets, 26 in. by from 6 to 10 ft. flat steel, made corrugated with corrugations about 1 in. in depth and 5 in. between centres of corrugations, laying 24 in. wide, with from 3 to 6 in. lap, according to pitch of roof, weigh about one-third more than flat sheets of same area.

For roofing, No. 24 is more generally used, while No. 26 is used for siding. Tack with wire nails on ends only and lap one corrugation on sides and from one to two inches on ends. The nail heads are sometimes soldered to assure absolute impermeability. The usual method, however, is to place lead washers under the heads.

Lumber.—When computing the amount of material required to cover a specified area, add to the area:

For 1 by 6 in. tongue and groove, 20%.
For 1 by 4 in. tongue and groove 25%.
For 1 by 4 in. tongue and groove kiln dried, 30%.
For rustic, 25%.

Nails.—For 1,000 shingles allow 4 lb. of 4d nails or 3½ lb. of 3d nails.

For 1,000 lath allow 6 lb. 3d fine nails.

For 1,000 ft. of clapboarding allow 18 lb. of 6d box nails.

For 1,000 ft. of board siding allow 20 lb. 8d or 25 lb. 10d common nails.

For 10 ft. of partition studding allow 1 lb. of 10d common nails.

For 1,000 ft. of 1 by 3 in. flooring allow 45 lb. 10d common nails.

For 1,000 ft. of 1 by 2 in. flooring allow 65 lb. 10d common nails.

For 1,000 ft. of pine finish allow 30 lb. of 8d wire nails.

Brick.—A 4½-in. wall requires 7 brick per sq. ft. of surface.

A 9-in. wall requires 14 brick per sq. ft. of surface.

A 13-in. wall requires 20 brick per sq. ft. of surface.

An 18-in. wall requires 26½ brick per sq. ft. of surface.

A 21-in. wall requires 33 brick per sq. ft. of surface.

A 27-in. wall requires 39½ brick per sq. ft. of surface.

The weight of brickwork is 112 pounds per cu. ft.

Laid brick will crush at 500 lb. per sq. in. or at 72,000 lb. per sq. ft.

Fire brick weighs 150 lb. per cu. ft.

Cement concrete weighs 140 lb. per cu. ft.

A bricklayer should average 1,500 bricks in 8 hours, and 2,000 to 2,400 when starting wall before staging or ladder is used. Staging is used above 4 ft.

Brick at $10 and labor at $7.50 per 1,000 should be considered good work.

Concrete.—Formula No. 1—For retaining walls and machinery foundations: 60 cu. ft. of rock that will pass a 3-inch mesh screen; 20 cu. ft. of clean, sharp, coarse sand; 10 cu. ft. of Portland cement. Formula No. 2—For concrete mortar blocks for stamp batteries: 52 cu. ft. of rock; 32 cu. ft. of sand; 16 cu. ft. of cement.

If broken rock is not available, clean creek gravel of the same size may be substituted, but in no case use clay, loam or very fine sand. Mix all together dry. When required for use, mix small quantities with sufficient water to make a thick mortar, use immediately and tamp with a tamping bar. Concrete will set sufficiently in 24 hours to sustain a load, and in from three to four days in medium dry weather machinery may be run on the foundations.

An average figure for cost of reinforced concrete construction on the Pacific Coast is 50c per cubic foot.

STANDARD SIZES OF LABORATORY SCREENS AS ADOPTED BY THE INSTITUTION OF MINING AND METALLURGY (LONDON).

Mesh	Diameter of Wire		Aperture		Screening Area,
	in.	m.m.	in.	m.m.	per cent
5	0.1	2.54	0.1	2.54	25.00
8	0.063	1.60	0.062	1.574	24.60
10	0.05	1.27	0.05	1.27	25.00
12	0.041	1.06	0.04	1.05	24.92
16	0.03	0.79	0.03	0.79	24.92
20	0.25	0.63	0.25	0.63	25.00
30	0.01	0.42	0.01	0.42	24.80
40	0.01	0.31	0.01	0.31	25.00
50	0.01	0.25	0.01	0.25	25.00
60	0.008	0.21	0.008	0.21	24.80
70	0.007	0.18	0.007	0.18	24.70
80	0.006	0.16	0.006	0.15	24.60
100	0.005	0.12	0.005	0.12	25.00
150	0.003	0.084	0.003	0.084	24.50
200	0.002	0.063	0.002	0.063	25.00

WATER POWER.

The power of water may be utilized by four different methods, as follows:

1. By its dead weight, as in an over-shot water-wheel.
2. By its direct pressure, as in a turbine.
3. By its acquired impulse or kinetic energy, as in a tangential water-wheel, the hydraulic giant, the hydraulic elevator, etc.
4. By a combination of the above.

The total power is dependent on two principal factors, the head (or pressure), and the volume (or weight). The actual power is the power available after deducting various losses due to friction and the inefficiency of the machine, etc.

The head is known under two terms, the "static head" and the "effective head." The "static head" is the actual vertical difference of level between the intake of the water at the head of the pipe and its point of discharge where the power is used. The "effective head" is the actual head available for power purposes after subtracting the energy expended in overcoming the friction of the pipe line and allowing for any other losses that may occur.

For a proper understanding of any hydraulic proposition the following information is necessary:

1. Amount of water available.
2. Head or vertical fall from ditch or source of supply to a point where the wheel is to be placed.
3. Length of pipe necessary to obtain given head. When submitting information to manufacturers for estimates of cost it is also advisable to furnish a profile of the proposed pipe line, especially if the line is to be of considerable length and under heavy pressure. The tables on page 67 will assist in obtaining approximations of available power when in the field.

   The miner's inch of water is of California origin and varies in different localities to such an extent that it is better to estimate the amount of water available in cu.ft. per minute. For usual calculations a miner's inch is equal to a flow of 1.5 cu. ft. or 11.25 gal. per minute.

The most accurate method of measuring the flow of water is the weir measurement, but sometimes a rough approximation is desired and the measurement by cross section and velocity is used.

Select a stretch on a stream or ditch which will afford as straight and uniform a course as possible, avoiding pools or obstructions to the normal flow. If the water is at any point carried in a flume, it is better to measure at this point. Lay off a distance of, say 100 feet; measure the width of flowing water at about six different places in this distance, and obtain the average width; likewise at these same points measure the depth of water at three or four places across the stream, and obtain the average depth. Next, drop a float in the water, noting the number of seconds it takes to travel the given distance. Do this several times and take the average. From this can be calculated the velocity of the water in feet per second. The cubic quantity is the product obtained by multiplying the average width in feet by the average depth in feet by the velocity, which (if in feet per second) will give the flow of the stream in cubic feet per second. From the figures so obtained it is advisable to deduct about 25 per cent as the surface velocity of water is in excess of the actual average velocity, or a distance of 120 ft. can be taken and figured as 100 ft.

FLOW IN FLUMES AND DITCHES.

The carrying capacity of a ditch depends on its size, slope and the nature of its surface over which the water flows. The following tables give approximate results assuming average conditions and smooth channels.

DIMENSIONS OF DITCHES, GIVING DISCHARGE OF WATER IN CUBIC FEET PER MINUTE FOR DIFFERENT GRADES.

T, top width; B, bottom width; D, depth.

Base to Perpendicular of Side Slopes being as 3 to 4.

Fall ft. per Mile	T. 3.3 ft. B. 1.5 ft. D. 1.2 ft. Section 2.88 sq. ft.	T. 5.5 ft. B. 2.5 ft. D. 2.0 ft. Section 8.0 sq. ft.	T. 7.7 ft. B. 3.5 ft. D. 2.8 ft. Section 15.68 sq. ft.	T. 9.9 ft. B. 4.5 ft. D. 3.6 ft. Section 25.92 sq. ft.	T. 11 ft. B. 5 ft. D. 4 ft. Section 32 sq. ft.	T. 13.2 ft. B. 6.0 ft. D. 4.8 ft. Section 46.09 sq. ft.
	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.
1	1.33	5.57	13.46	28.04	37.1	58.4
2	1.88	7.88	19.04	39.67	52.4	82.7
3	2.30	9.65	23.32	48.59	64.2	101.4
4	2.65	11.14	26.93	59.10	74.1	117.1
5	2.97	12.46	30.11	62.71	82.9	130.9
6	3.25	13.65	32.98	68.70	90.8	143.4
7	3.42	14.74	35.63	74.19	98.1	154.8
8	3.75	15.75	38.08	79.53	104.8	165.5
9	3.98	16.71	40.39	84.14	111.1	175.6
10	4.19	18.47	42.57	88.68	117.1	185.1
11	4.40	19.30	44.65	93.02	122.9	194.1
12	4.60	20.08	46.64	97.15	128.4	202.8

Base to Perpendicular of Side Slopes being as 2 to 1.

Fall ft. per Mile	T. 6 ft. B. 2 ft. D. 1 ft. Section 4 sq. ft.	T. 9 ft. B. 3 ft. D. 1.5 ft. Section 9 sq. ft.	T. 12 ft. B. 4 ft. D. 2 ft. Section 16 sq. ft.	T. 16 ft. B. 6 ft. D. 2.5 ft. Section 27.50 sq. ft.	T. 22 ft. B. 10 ft. D. 3 ft. Section 48 sq. ft.	T. 28 ft. B. 12 ft. D. 4 ft. Section 30 sq. ft.
	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.
1	1.79	5.44	12.20	25.61	54.86	110.6
2	2.53	7.69	17.26	36.22	75.58	156.5
3	3.10	9.42	21.14	44.36	95.00	191.6
4	3.58	10.87	24.41	51.22	109.70	221.3
5	4.00	12.16	27.29	57.27	122.70	247.4
6	4.38	13.31	29.89	62.74	134.40	271.0
7	4.73	14.39	32.29	67.78	145.10	292.7
8	5.06	15.38	34.52	72.43	155.20	312.9
9	5.37	16.31	36.61	76.83	164.60	331.9
10	5.66	17.19	38.59	80.99	173.50	349.0
11	5.93	18.03	40.47	84.94	181.90	366.9
12	6.20	18.74	42.27	88.72	190.10	383.2

Ditches should never be run full but should be constructed large enough, so that they will carry the desired amount when about three-quarters full. Ditches should have a uniform grade, otherwise there will be an accumulation of sand and silt at some points and an increased danger from breakage. It is also necessary to have waste weirs to carry off surplus waters occasioned by floods, and to lessen the danger of breaks. In cases where banks will stand it, it is at times advisable to use narrow deep ditches, rather than wide flat ditches, as a greater average velocity can be obtained in a deep stream, than in a shallow stream. Each location has to be treated in accordance with its own special conditions, and no general rule can be laid down. In mountainous countries, where the ground is hard and can resist the rapid flow, deep narrow ditches with steep grades are generally preferred to larger channels with less grade, as the cost of excavation is considerably less.

FLOW OF WATER IN PIPES.

This is a complex question and one requiring careful engineering to obtain the best and most economical results. A considerable amount of power can be wasted by undue friction of water in the pipe line, and it is necessary to proportion the diameter of the pipe to the flow of water so that there shall be the least possible loss of head consistent with reasonable economy in the first cost of pipe. Where sufficient head is obtainable, it may be economical to use a comparatively small pipe and waste some head in overcoming friction. Where a high head is to be utilized and the pipe has to withstand great pressure, it may be advisable to put in as small a pipe as will conveniently handle the water for the reason that sheet steel of equal thickness will resist a greater bursting pressure on a small pipe than in one of larger diameter. It is impossible to construct an arbitrary table of pipe dimensions for all the different conditions that may arise. Anyone interested will find the subject treated at length in Trautwine's Pocket Book and various books on hydraulics. Considerable information of practical value will also be found in catalogues issued by the Pelton Water Wheel Company, Hendy Iron Works and Union Iron Works—of San Francisco.

TABLE FOR CALCULATING THE HORSE POWER OF WATER

MINERS' INCH TABLE. The following table gives the Horse Power of one miners' inch of water under heads from one up to eleven hundred feet. This inch equals 1½ cubic feet per minute.				CUBIC FEET TABLE. The following table gives the Horse Power of one cubic foot of water per minute under heads from one up to eleven hundred feet. Tables are based on an efficiency of 85%.			
Heads in Feet	Horse Power	Heads in Feet	Horse Power	Heads in Feet	Horse Power	Heads in Feet	Horse Power
1	0.0024147	290	0.700263	1	0.0016098	290	0.466842
20	0.0482294	300	0.724410	20	0.032196	300	0.482940
30	0.072441	320	0.772704	30	0.048294	320	0.515136
40	0.096588	340	0.820998	40	0.064392	340	0.547332
50	0.120735	350	0.845145	50	0.080490	350	0.563430
60	0.144882	370	0.893439	60	0.096588	370	0.595626
70	0.169029	390	0.941733	70	0.112686	390	0.627822
80	0.193176	400	0.965880	80	0.128784	400	0.643920
90	0.217323	420	1.014174	90	0.144892	420	0.676116
100	0.241470	440	1.062468	100	0.160980	440	0.708312
110	0.265617	450	1.086615	110	0.177078	450	0.724410
120	0.289764	460	1.110762	120	0.193176	460	0.740508
130	0.313911	470	1.134909	130	0.209274	470	0.756606
140	0.338058	480	1.159056	140	0.225372	480	0.772704
150	0.362205	500	1.207350	150	0.241470	490	0.788802
160	0.386352	520	1.255644	160	0.257568	500	0.804900
170	0.410499	540	1.303938	170	0.273666	520	0.837096
180	0.434646	560	1.352232	180	0.289764	540	0.869292
190	0.458793	580	1.400526	190	0.305862	560	0.901488
200	0.482940	600	1.448820	200	0.321960	580	0.933684
210	0.507087	650	1.569555	210	0.338058	600	0.965880
220	0.531234	700	1.690290	220	0.354156	650	1.046370
230	0.555381	750	1.811025	230	0.370254	700	1.126860
240	0.579528	800	1.931760	240	0.386352	750	1.207350
250	0.603675	900	2.173230	250	0.402450	800	1.287840
260	0.627822	1000	2.414700	260	0.418548	900	1.448820
270	0.651969	1100	2.656170	270	0.434646	1000	1.609800
280	0.676116			280	0.450744	1100	1.770780

Multiply the amount of water available in inches or cubic feet by the factor given for the effective head and the result will be the obtainable horsepower based upon an efficiency of 85%.

Example: 100 in. of water 150 ft. effective head.
100 x .3622=36.22 h.p.

HYDRAULIC EQUIVALENTS.

1 second-foot equals 40 California miner's inches (law of March 23, 1901).

1 second-foot equals 38.4 Colorado miner's inches.

1 second-foot equals 40 Arizona miner's inches.

1 second-foot equals 7.48 United States gallons per second; equals 448.8 gallons per minute; equals 646,272 gallons for one day.

1 second-foot equals about 1 acre-inch per hour.

1 second-foot for one day equals 1 square mile 0.03719 inch deep.

1 second-foot for one day equals 1.983 acre-feet.

100 California miner's inches equals 18.7 United States gallons per second.

100 Colorado miner's inches equals 19.5 United States gallons per second.

1 acre-foot equals 325,850 gallons.

1 cubic-foot equals 7.48 gallons.

1 cubic foot of water weighs 62.5 pounds.

1 horse-power equals 1 second-foot falling 8.80 feet.

To calculate water-power quickly:

$$\frac{\text{Sec.-ft.} \times \text{fall in feet}}{11} = \text{net horse-power on water-wheel realizing } 80\% \text{ of theoretical power.}$$

The pressure of water in pounds per square inch of surface due to head or depth is equal to 0.434 pounds for each foot of head or depth.

$$p = H \times 0.4335$$
$$H = p \times 2.307 = p \times \frac{1}{0.4335}$$
$$P = H \times 62.425$$

where

p=Pressure in lbs. per sq. inch.
H=Head of water in ft.
P=Pressure in lbs. per sq. ft.

PUMP DATA.

To find the capacity of a cylinder in gallons, multiply the area in inches, by the length of stroke in inches; divide this amount by 231, and quotient is the capacity in gallons. Ordinary speed to run pumps is 100 ft. of piston speed per min.

To find quantity of water elevated in one minute running at 100 ft. of piston speed per minute, square the diameter of water cylinder in inches and multiply by 4. Example, capacity of a five-inch cylinder is desired. The square of the diameter (5 inches) is 25, and multiplied by 4 gives 100, which is gallons per minute (approximately).

To find the diameter of a pump cylinder to move a given quantity of water per minute (100 feet of piston being the standard of speed), divide the number of gallons by 4; then extract the square root, and the product will be the diameter in inches of the pump cylinder.

To find the horse-power necessary to elevate water to a given height, multiply the total weight of column of water in pounds, by the velocity per minute in feet, and divide the

product by 33,000 (an allowance of 25% should be added for friction, etc.), or multiply the number of gallons per minute by the head in feet and divide the product by 3960.

The mean pressure of the atmosphere is usually estimated at 14.7 lbs. per square inch, so that with a perfect vacuum it will sustain a column of mercury 29.9 inches or a column of water 33.9 ft. high, though 20 ft. is the greatest suction lift it is advisable to use.

To find the pressure in pounds per square inch of a column of water, multiply the height of the column in feet by 0.434.

The area of the steam piston, multiplied by the steam pressure, gives the total amount of pressure that can be exerted. The area of the water piston, multiplied by the pressure of water per square inch, gives the resistance. A margin must be made between the power and the resistance to move the pistons at the required speed—say from 20 to 40%, according to the speed and other conditions.

The weight of water in a pipe may be approximately estimated by squaring the diameter of the pipe in inches and the result will be the weight of water in lbs. per yard of pipe.

COST OF POWER PLANTS.

The cost of power plants using a steam prime mover and electric generators is discussed in the journal of the Association of Engineers' Society, January 1912. The figures given for a station of this type having steam turbines with coal costing $4.25 a ton are as follows:

Size of Plant. kw.	Cost per kw. of capacity.	Power Cost per kw. hr.
1000	$125	$1.25
2000	110	1.08
3000	100	1.00
4000	95	.96
5000	90	.94

COST OF POWER TRANSMISSION LINES.

It would be possible to give a large number of figures relating to material and labor costs of completed transmission lines; but the conditions of transport of materials and quality of labor differ widely, and without complete knowledge of these conditions, such figures are liable to be misleading. For this reason two ideal preliminary estimates, one referring to

a wood pole line, and the other to a steel line, are here reproduced, in the hope that they may be useful as a basis on which somewhat similar estimates may be shaped.

PRELIMINARY ESTIMATE NO. 1.

Wood pole transmission line, 20 miles long, carrying one three-phase line. Line pressure 22,000 volts. Span 130 ft. There is no grounded overhead guard wire; but two telephone wires are carried on the same set of poles. An allowance of 20% is made for extra insulators and fixtures to permit of doubling these on corner poles and in other selected positions.

MATERIALS (EXCLUDING CONDUCTORS).

40	creosoted cedar poles, 35 ft. long, 8 in. diam. at top	$400.00	
48	cross-arms, 3½ by 4½ in. by 4 ft. long	14.50	
96	galvanized iron braces, 1¼ by ¼ by 28 in. long	9.00	
32	galvanized bolts, ⅝ by 12½ in., with washers		
8	galvanized bolts, ⅝ by 16 in., with washers		
16	galvanized spacing rods, ¾ by 16 in., with nuts and washers	7.50	
48	galvanized lag screws, ½ by 3½ in.		
96	galvanized carriage bolts, ⅜ by 4½ in.		
1500	ft. galvanized 7-strand 5/16 in. guy wire	12.00	
12	anchor rods with nuts and washers and necessary timber for anchor logs	7.00	
24	galvanized guy clamps with bolts	3.00	
8	galvanized sheet-iron bands to prevent cutting of poles by guy wire	0.50	
12	standard thimbles for guy wire	0.40	
20	galvanized-iron lightning conductors, with bolts	5.50	
20	ground plates or galvanized iron pipes	8.00	
	Staples and sundries, including allowance for breakages and contingencies	15.00	
80	telephone wire insulators (glass)		
80	side brackets for same (wood); 5-in. wire nails	10.00	
144	H.T. porcelain insulators	36.00	
96	galvanized-iron insulator pins with porcelain bases	14.40	
48	special pole-top insulator pins, with bolts	19.20	
	Total material cost per mile of line		$562.00

LABOR.

Clearing 50 ft. on each side of pole line @ $30 per acre	$363.00		
Distributing poles and other materials along the line	30.00		
Trimming poles, cutting gains, drilling holes, setting cross-arms	30.00		
Digging holes and erecting poles, including the necessary guying	80.00		
Fixing insulators and stringing wires, including telephone line	90.00		
Supervision and sundry small labor items	30.00		
Loss and depreciation of tools	10.00		
Management and preliminary work	25.00		
Total cost per mile for charges other than materials		$658.00	
Total cost per mile, excluding cost of conductor material			$1220.00

CONDUCTORS

16,000 ft. No. 1 copper conductors (hard-drawn); 700 ft. No. 4 copper for ties (soft); 10,800 ft. No. 10 copper for telephone circuit; 4550 lb. @ $15 per 100 lb.	682.50
Total cost of finished line	$1902.50

PRELIMINARY ESTIMATE NO. 2.

'Flexible' type steel tower line, 60 miles long, with two sets of 3-phase conductors. Line pressure = 80,000 volts. Average span, 480 ft. Spacing between wires, 8½ ft. A Siemens-Martin steel cable, acting as grounded guard wire, joins the top of all towers. Insulators of the suspension lowest H.T. conductor and ground = 40 ft. Cost of right-of-way not included in estimate.

Materials (Excluding Conductors)

10	flexible type, galvanized-steel, A-frame towers @ $85.	$850.00	
1	galvanized-steel strain tower	170.00	
	Concrete foundations where necessary	80.00	
5600	ft. 7/16 in. galvanized Siemens-Martin steel-strand cable for guard wire and head guys on half-mile flexible towers	128.00	
4	anchor rods, complete with clamps and thimbles for guy wire	4.00	
90	sets of suspension-type insulators, including strain insulators and small allowance for breakages, complete with clamps	338.00	
	Sundry small items or special material	50.00	
	Total material cost per mile of line		$1620.00

Labor

Clearing 60 ft. on each side of line at average cost of $25 per acre	$363.00	
Distributing towers and other materials along the line	100.00	
Foundations for towers	75.00	
Assembly of parts and erection of towers	160.00	
Fixing insulators and stringing wires	170.00	
Supervision and sundry small labor items	50.00	
Allowance for loss and depreciation of tools	15.00	
Allowance for management and preliminary work	35.00	
Total charges other than materials per mile		968.00

Total cost per mile not including conductor material...... $2588.00

Conductors

No. 00, hard-drawn, stranded-copper conductors; small amount of No. 2 soft copper for occasional ties; special clamps, shields, jointing materials, etc.; 13,350 lb. @ $15 per 100 lb. 2002.00

Total cost per mile of finished line, not including right-of-way......$4590.00

STEAM.

The best designed boilers, well set, with good draft, and skillful firing, will evaporate from 7 to 10 lb. of water per pound of first-class coal. In calculating horse-power of tubular or flue boilers, consider 15 sq. ft. of heating surface equivalent to one nominal horse-power. On one square foot of grate can be burned on an average from 10 to 12 lb. of hard

coal, or 18 to 20 lb. of soft coal, per hour, with natural draft. With forced draft nearly double this amount can be burned.

Steam engines, in economy, vary from 14 to 60 lb. of feed water and from 1½ to 7 lb. of coal per hour per indicated horse-power.

Condensing engines require from 20 to 30 gal. of water, at an average low temperature, to condense the steam represented by every gallon of water evaporated in the boilers supplying engines, approximately for most engines, we say, from 1 to 1½ gal. condensing water per minute per indicated horse-power.

STANDARD HOISTING ROPES.

Composed of 6 strands of 19 wires each, with hemp center.

		Allowable working strain in tons of 2,000 lb. Factor of safety=5.				Minimum Size of Drum or Sheave in Feet.			
Diameter	Wgh. per Foot in Pounds	Plough Steel	Ex. Strong Crucible Steel	Cast Steel	Swedish Iron	Plough Steel	Ex. Strong Crucible Steel	Cast Steel	Swedish Iron
2¾	12.00	61.0	53.0	45.0	22.8	11	10	10	16
2½	10.00	50.0	45.0	38.0	18.9	10	9½	9½	15
2¼	8.00	41.0	36.0	31.0	15.6	9	8½	8½	13
2	6.30	33.0	28.0	24.0	12.4	8	8	8	12
1¾	4.85	25.0	22.0	19.0	9.6	7½	7¼	7¼	10
1⅝	4.15	22.0	19.0	16.0	8.4	6	6¼	6¼	8½
1½	3.55	19.0	16.0	14.0	7.2	5½	5¾	5¾	7½
1⅜	3.00	16.0	14.0	12.0	6.2	5¼	5½	5½	7
1¼	2.45	13.0	11.0	10.0	5.0	5	5	5	6½
1⅛	2.00	11.0	9.8	8.4	4.2	4½	4½	4½	6
1	1.58	8.8	7.8	6.8	3.4	4¼	4	4	5¼
⅞	1.20	6.8	6.0	5.2	2.6	3¾	3½	3½	4½
¾	0.89	5.0	4.4	3.88	1.94	3½	3	3	4
⅝	0.62	3.6	3.16	2.72	1.36	3	2¼	2¼	3½
9/16	0.50	2.9	2.54	2.20	1.10	2½	1¾	1¾	2¾

RELATIVE COST OF OIL AND COAL FOR FUEL ON A STEAMER.

The following table of comparative cost of fuel on steamers was compiled by Geo. W. Dickie. Oil is figured at $1 per barrel. Indicated horse-power of steamer 3000, steaming speed 11 knots. Figures cover assumed delivery costs of coal of assumed qualities in quantities sufficient to do the same work as done by the oil.

Cost of Oil Fuel per day	Quality of Coal b. t. u. per lb.	Tons coal per day neces-sary	Add for addi-tional labor	Costs per day for several qualities of coal at the following prices deliv-ered.		
				$4.00	$6.00	$8.00
$300.00	12,000	62.70	37.56	288.36	413.76	513.16
	11,000	68.40	37.56	311.16	447.96	584.76
	10,000	75.20	37.56	338.36	488.75	639.16
	9,000	83.60	37.56	371.96	539.16	706.36

Since it is impossible in practice to obtain coal having a calorific power of 12,000 b. t. u. at a cost of $4 per ton, it is evident that oil is the more economical fuel. In every other case figured in the above table the advantage is with the oil, and the figures are widely representative.

RELATIVE VALUES OF WOOD, COAL AND OIL.

2 lb. of crude oil	=	1 h.p.hour.
48 " " " "	=	1 h.p. for 24 hours.
1440 " " " "	=	1 h.p. for 30 days.
337 " " " "	=	1 barrel.
4 bbl. oil	=	1 h.p. for 30 days.
42 gal. oil	=	1 barrel.
8 lb.	=	1 gallon.

Wood		Kern River Oil Barrels
1 cord oak	=	2.5
1 " average pine	=	2.0
1 " heavy fat pine	=	2.25 to 2.5
1 " dry redwood	=	2.0
1 " average redwood	=	1.75

Coal.		
1 ton Welsh anthracite	=	5.
1 " Australian bulls eye	=	4.
1 " Australian, Sydney	=	4.
1 " Wellington	=	3.5
1 " South Prairie	=	3.5
1 " Franklin	=	3.5
1 " White Ash	=	3.5
1 " Wellington Screenings	=	3.
1 " Roslyn	=	3.
1 " Coos Bay	=	2.5 to 3.
1 " Seattle	=	2. to 2.5
1 " Tesla	=	1.75 to 2.25

COMPANY REPORTS.

WHAT COMPANY REPORTS SHOULD CONTAIN.*

1. Details as to capitalization, number and classes of shares outstanding, the respective rights of these shares, number of shares in treasury, any options, contracts, or shares, any bonded indebtedness.
2. A brief review of the past history of the property, the work accomplished and the results obtained, with tabulated statement of expenditures and receipts from beginning; marketable products made each year and the sums received from sale of same; annual net earnings and disposition made of same.
3. A similar review but in more detail of the work of the year, with statements of liabilities, receipts and disbursements, cost sheets and other information as to work accomplished and results obtained.
4. A statement of ore reserves at the date of report compared with ore reserves of the previous year and estimate by competent authority of the probable life of the mine.

FLOW-SHEET.

A good form for presenting a flow-sheet is shown in Fig. 3. The example is that of the 40-stamp mill erected for the Dome Mines Co. by the Merrill Metallurgical Co. The figures in the illustration correspond to machines and data as below: (1) hoist; (2) Kenedy No. 7½ gyratory crusher; (3) Kenedy No. 5 gyratory crusher; (4) belt-conveyor to mill-bins; (5) battery storage-bin; (6) four 10-stamp batteries, 1250-lb. stamps, 102 drops per minute; (7) primary amalgamating-plates, 54 by 144 in., slope 1½ in. per foot, plates in two sections; (8) four duplex Dorr classifiers; (9) four 5 by 22 A. C. tube-mills, El Oro lining, scoop feed, spiral discharge, 31 r.p.m.; (10) secondary amalgamating-plates, 108 by 144 in., slope ½ in. per foot, in two sections; (11) five Frenier pumps, 8 by 54 in.; (12) two concentrating-cone units; (13) three Dorr thickeners, 30 by 10 ft.;

*From resolutions adopted by the Mining and Metallurgical Society of America.

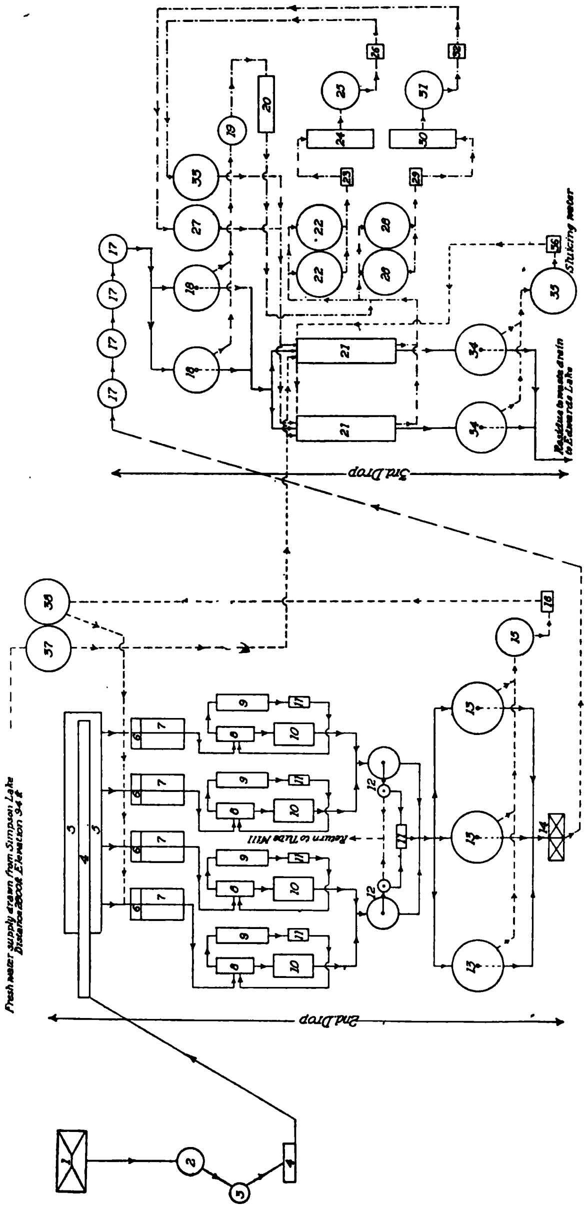

Fig. 3.—Flow Sheet, Dome Mill.

(14) duplex bucket-elevator, centre to centre 70 ft., buckets 7 by 16 in.; (15) return battery-water sump, 10 by 10 in.; (16) return battery-water pump, Aldrich vertical triplex, 350 gal. per minute, 15-hp. motor; (17) four continuous agitators 8 by 40 ft.; (18) two Dorr thickeners 25 by 10 ft.; (19) thickener overflow tank 10 by 10 ft.; Merrill clarifying-press; (21) two Merrill slime-presses, 76 four-inch frames, Dome type; (22) two strong-solution precipitating-vats, 25 by 10 ft.; (23) strong-solution precipitation pump, Aldrich vertical triplex, 175 gal. per min., 7½-hp. motor; (24) strong-solution (Merrill) precipitation-press, 52-in. press, 20 two-inch frames; (25) strong barren-solution sump 20 by 10 ft.; (26) strong barren-solution pump, Aldrich vertical triplex, 175 gal. per min., 7½-hp. motor; (27) strong barren-solution storage tank 25 by 10 ft.; (28) two weak-solution precipitating-vats, 25 by 10 ft.; (29) weak-solution precipitation-pump, Aldrich vertical triplex, 100 gal. per min., 5-hp. motor; (30) weak-solution (Merrill) precipitation-press, 10 two-inch frames; (31) weak barren-solution sump, 20 by 10 ft.; (32) weak barren solution pump, Aldrich vertical triplex, 100 gal. per min., 5-hp. motor; (33) weak barren-solution storage-tank, 25 by 10 ft.; (34) two Dorr thickeners, 30 by 10 ft.; (35) sluicing-water sump, 25 by 10 ft.; (36) sluicing-water pump, Aldrich vertical triplex, 700 gal. per min., 50-hp. motor; (37) fresh-water storage-tank, 25 by 20 ft.; (38) battery-water storage-tank, 25 by 10 feet.

TABLE OF NATURAL CIRCULAR FUNCTIONS.

	Sine	Tang	Co-sine	Co-tang	
1	.0175	.0175	.9999	57.290	89
2	.0349	.0349	.9994	28.636	88
3	.0523	.0524	.9986	19.081	87
4	.0698	.0699	.9976	14.307	86
5	.0872	.0875	.9962	11.430	85
6	.1045	.1051	.9945	9.514	84
7	.1219	.1228	.9926	8.144	83
8	.1392	.1405	.9903	7.115	82
9	.1564	.1584	.9877	6.314	81
10	.1737	.1763	.9848	5.671	80
11	.1908	.1944	.9816	5.145	79
12	.2079	.2126	.9782	4.704	78
13	.2250	.2309	.9744	4.331	77
14	.2419	.2493	.9703	4.011	76
15	.2588	.2680	.9659	3.732	75
16	.2756	.2868	.9613	3.487	74
17	.2924	.3057	.9563	3.271	73
18	.3090	.3249	.9511	3.078	72
19	.3256	.3433	.9455	2.904	71
20	.3420	.3640	.9397	2.747	70
21	.3584	.3839	.9336	2.605	69
22	.3746	.4040	.9272	2.475	68
23	.3907	.4245	.9205	2.356	67
24	.4067	.4452	.9136	2.246	66
25	.4226	.4663	.9063	2.144	65
26	.4384	.4877	.8988	2.050	64
27	.4540	.5095	.8910	1.963	63
28	.4695	.5317	.8830	1.881	62
29	.4848	.5543	.8746	1.804	61
30	.5000	.5774	.8660	1.732	60
31	.5150	.6009	.8572	1.664	59
32	.5320	.6249	.8480	1.600	58
33	.5446	.6494	.8387	1.540	57
34	.5592	.6745	.8290	1.483	56
35	.5736	.7002	.8192	1.428	55
36	.5878	.7265	.8090	1.376	54
37	.6018	.7536	.7986	1.327	53
38	.6157	.7813	.7880	1.280	52
39	.6293	.8098	.7772	1.235	51
40	.6428	.8391	.7660	1.192	50
41	.6560	.8693	.7547	1.150	49
42	.6691	.9004	.7431	1.111	48
43	.6820	.9325	.7314	1.072	47
44	.6947	.9657	.7193	1.035	46
45	.7071	1.00	.7071	1.000	45
	Co-sine	Co-tang	Sine	Tang	

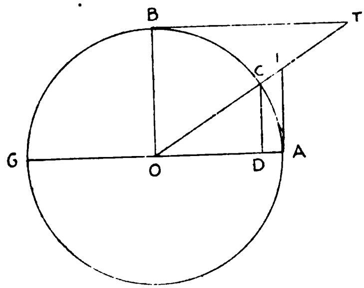

Diagram Illustrating Circular Functions.

Angle OAC.
AG = Diameter.
AO = Radius.
DC = Sine.
OD = Cosine.
AF = Tangent.
BT = Cotangent.

Directions for Use of Tables.

Latitude (N or S) = Cosine of angle of bearing × distance.

Departure (E or W) = Sine of angle of bearing × distance.

Level difference = sine of angle of inclination × distance.

Horizontal measurement = Cosine of angle of inclination × distance.

Example: If the distance is 150 ft. and the bearing N. 18° W., the departure will be 150 × .309 = 46.36 ft. west. The latitude will be 150 × .951 = 142.65 ft. north.

Example: If an incline shaft is 300 ft. deep on an inclination of 25°, the vertical depth of the shaft will be 300 × .422 = 126.6.

The horizontal distance on the surface from the center of the collar of the shaft to a point directly over the bottom of the shaft will be 300 × .906 = 271.8 ft.

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